DESKPRO 386/20 FROM COMPAQ ▶

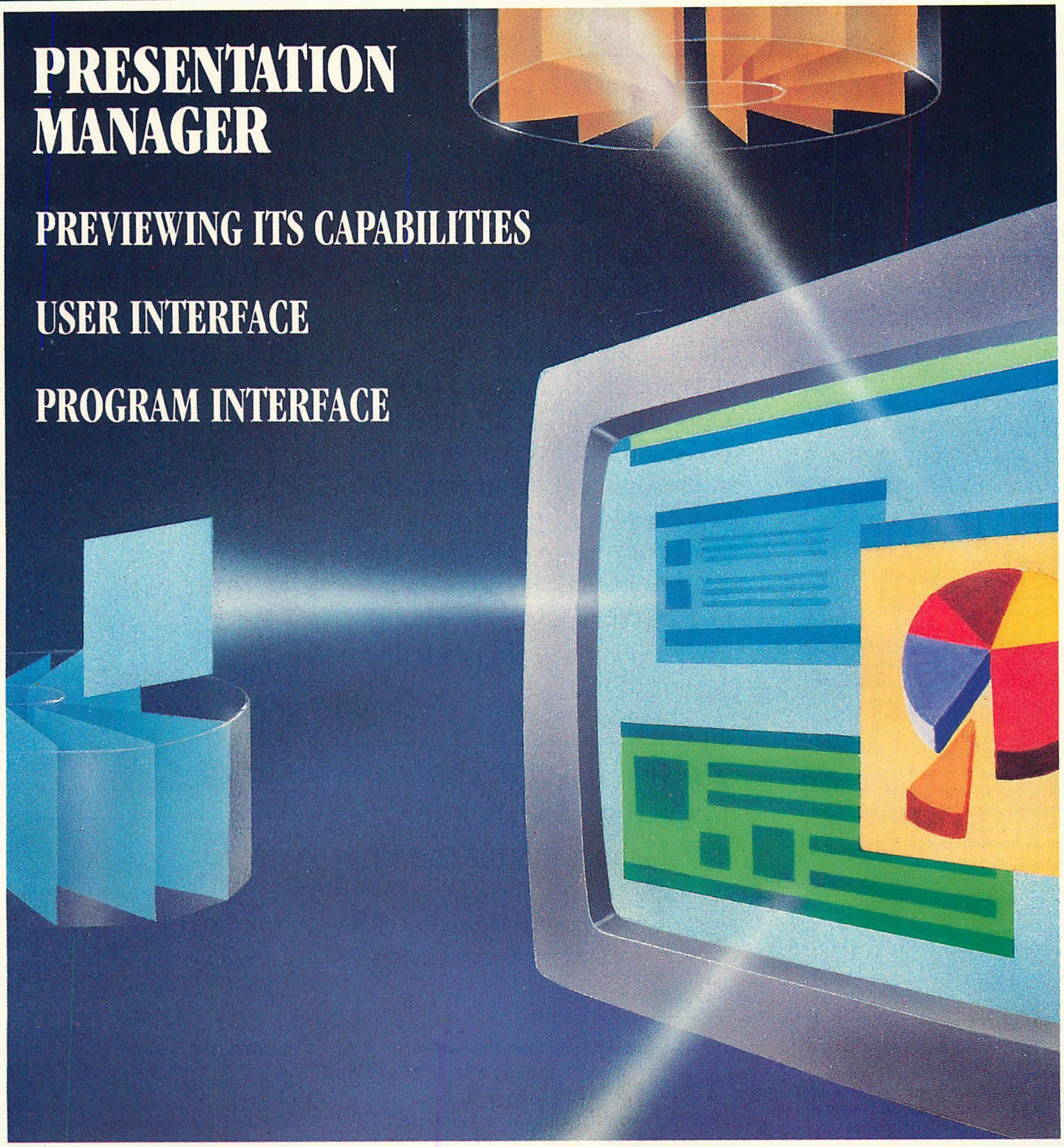
ADVANCED REVELATION

MARCH 1988

VOL. 6 NO. 3 $3.95

TECH PC JOURNAL®

FOR SYSTEMS DEVELOPERS AND INTEGRATORS



PRESENTATION MANAGER

PREVIEWING ITS CAPABILITIES

USER INTERFACE

PROGRAM INTERFACE

0 71486 02166 7 03

Why Parad

"Paradox® is once again the top-rated program, with the latest version scoring even higher than last year's top score." (Software Digest's July 1987 Ratings Report—an independent comparative ratings report for selecting IBM PC Business software).

All tests for the Ratings Report were done by the prestigious National Software Testing Laboratory, Philadelphia, PA, and the message is crystal clear: there is no better relational database manager than Paradox.

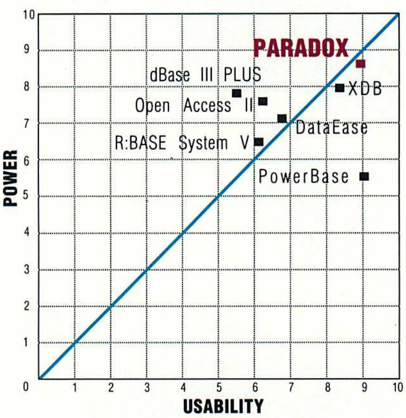
NSTL tested 12 different programs and amongst other results, discovered that Paradox is 3 times faster than dBASE; 6 times faster than R:BASE on a two-file join with subtotals test†.

Paradox does the impossible: combines ease-of-use with power and sophistication

Even if you're a beginner, Paradox is the only relational database manager that you can take out of the box and begin using right away.

Because Paradox employs state-of-the-art artificial intelligence technology, it does almost everything for you—except take itself out of the box.

If you've ever used 1-2-3® or dBASE®, you already know how to use Paradox. It has Lotus-like menus, and Paradox documentation includes "A Quick Guide to Paradox for Lotus users," and "A Quick Guide to Paradox for dBASE users."



*Source: Software Digest**

Ideal programs have high levels of both power and usability. Programs plotted in the upper righthand portion of the diagram above come closest to achieving that ideal.

> **"** Paradox still offers superior import/export facilities using Lotus 1-2-3, dBASE, ASCII and other file types. It transfers between formats with stunning speed
>
> *Rusel DeMaria, PC Week* **"**

Paradox responds instantly to "Query-by-Example"

The method you use to ask questions is called Query-by-Example. Instead of spending time figuring out *how* to do the query, you simply give Paradox an example of the results you're looking for. Paradox picks up the example and automatically seeks the fastest way of getting the answer. Paradox, unlike other databases, makes it just as easy to query multiple tables simultaneously as it is to query one.

*Source: Software Digest**

Software Digest Rating	Overall Evaluation	Program Name	Version Tested	Ease of Learning	Ease of Use	Error Handling	Performance	Versatility	Memory Requirement	Price
☆☆☆☆	8.7	Paradox	1.1	■	■	■	■	■	512K	$495
☆☆☆☆	8.2	XDB	1.10	■	■	■	■	■	320K	$750
☆☆☆	7.6	PowerBase	2.3	■	■	■	■	■	384K	$349
☆☆☆	7.0	Open Access II	2.0	■	■	■	■	■	256K	$395
☆☆☆	7.0	DataEase	2.5/2	■	■	■	■	■	384K	$600
☆☆	6.6	dBASE III PLUS	1.1	■	■	■	■	■	384K	$695
☆☆	6.4	R:BASE System V	1.1	■	■	■	■	■	512K	$700

RATINGS KEY
(On a scale of 0 to 10)
Overall Evaluation

☆☆☆☆☆ 9.0 or higher
☆☆☆☆ 8.0 - 8.9
☆☆☆ 7.0 - 7.9
☆☆ 6.0 - 6.9
☆ 5.0 - 5.9

All Other Ratings

■ 7.0 - 9.9
■ 5.0 - 6.9
■ UNDER 5.0

ox is the best

There's no power like Paradox Power

PROGRAM	Overall Power	Overall Performance	Overall Versatility	Single-Record Search (sec.)	Indexed Group Record Search (sec.)	Search without an Index (sec.)	Subtotal 100 Groups (sec.)	Subtotal on Two-File Join (sec.)	Three-File Join (sec.)	Subtotal on Three-File Join (sec.)	Four-File Join (sec.)	Many-to-Many Join (sec.)
Paradox	8.4	9.2	7.5	1.0	6	100	221	325	459	364	322	18
dBASE III PLUS	7.9	8.9	6.9	0.5	17	93	525	1013	646	449	445	39

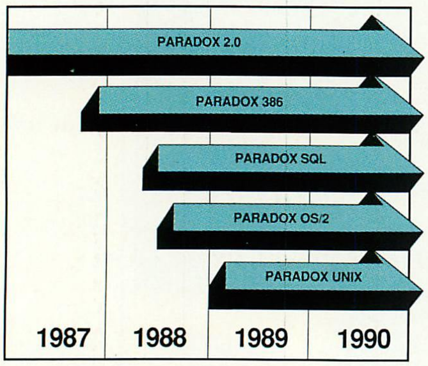
*Source: Software Digest**

Paradox makes your network run like clockwork

Paradox is just as valuable to multi and network users as it is to single users. It runs smoothly, intelligently and so transparently that multiusers can access the same data at the same time—without either being aware of each other or getting in each other's way. It works exactly the same way whether you're flying solo or as part of the crew.

Paradox saves you from future shock

Trends for the future with Paradox



Paradox 386 allows users to take advantage of 16 Megabytes of Memory on a 386 machine. This allows Paradox users to work with databases that could in the past only be handled by minicomputers and mainframes.

Your investment today in Paradox applications is protected as new hardware and operating systems are used in your company. Paradox 2.0 applications will run unchanged on Paradox 386, Paradox OS/2, Paradox Unix and Paradox SQL! All versions of Paradox will be completely application and menu compatible. Paradox SQL will allow access to remote databases via SQL. Users will just type in a query as they normally would, and Paradox will translate that Query to SQL.

"Paradox 2.0 will do for the LAN what the spreadsheet did for the PC

David Schulman,
Bendix Aerospace "

"Anyone who hasn't seen the network version of Paradox should take a look. Ansa has dramatically advanced the state of the art in multiuser network databases

Phil Lemmons,
BYTE

Paradox was a delight to use, both as a stand-alone product and from a local area network server.

Don Crabb,
InfoWorld "

How to make your network network

To run Paradox 2.0 or the Paradox Network Pack on a network you need:

- Novell with Novell Advanced Netware version 2.0A or higher
- 3Com 3Plus with 3Com 3+ operating system version 1.0, 1.1 or higher
- IBM Token Ring or PC Network with IBM PC Local Area Network Program version 1.12 or higher
- Torus Tapestry version 1.4 or higher
- AT&T Starlan Network with AT&T PC 6300 Network Program version
- Other network configurations that are 100% compatible with DOS 3.1 and one of the listed networks

System Requirements for Single User:

- DOS 2.0 or higher
- IBM® PS/2 and PC, Compaq® PC families and other 100% compatibles
- 512K RAM
- Two disk drives, 3½-inch and 5¼-inch supported
- Compatible monochrome, color, or EGA monitor with adapter

System Requirements for the Network Workstation:

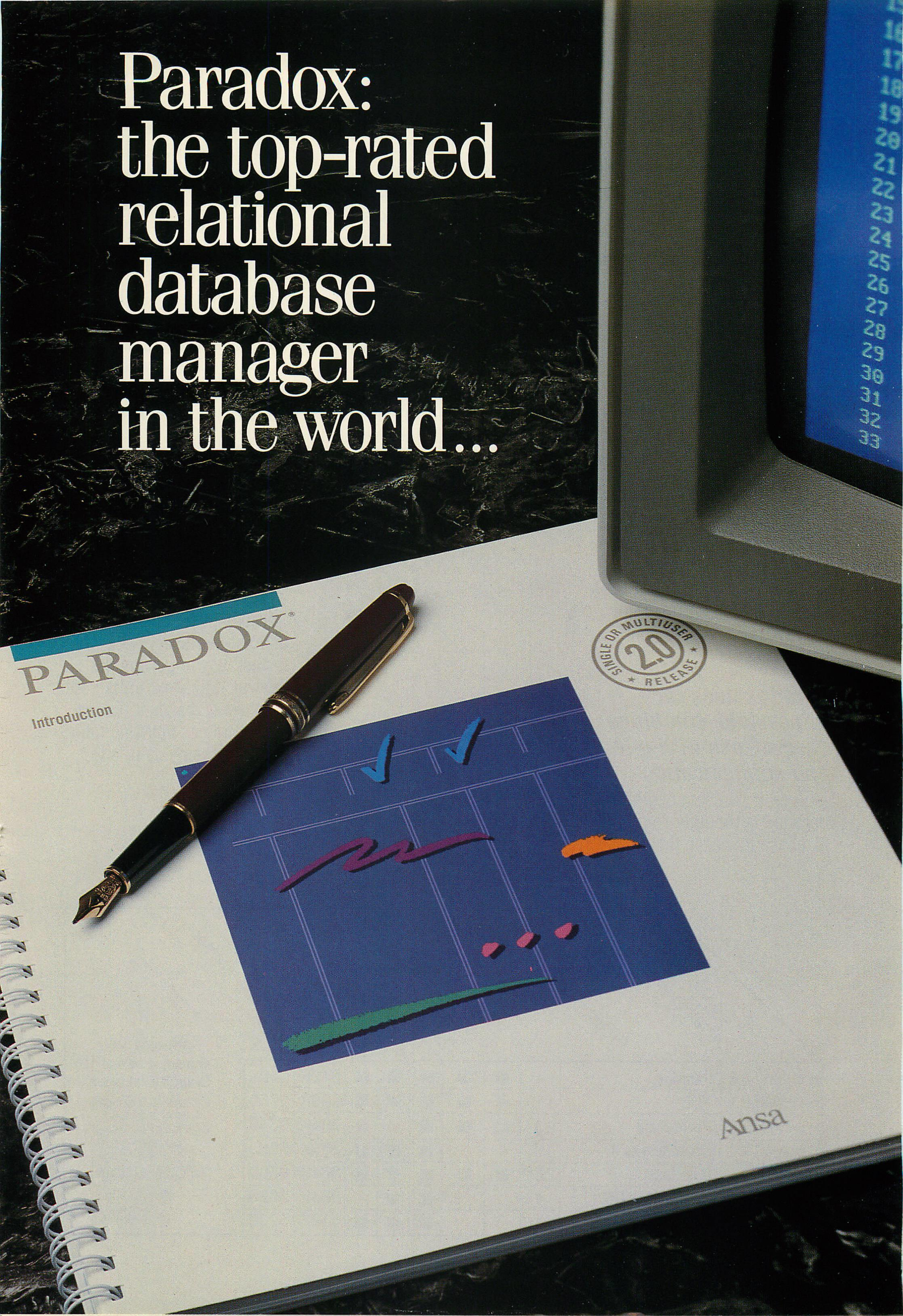
- DOS 3.1 or higher
- 640K RAM
- Any combination of hard, floppy, or no disk drives
- Compatible monochrome, color, or EGA monitor with adapter

Optional Equipment:

- EMS and EEMS Boards: AST RAMpage Board,™ Intel Above Board® or other expanded memory adapters
- Printers: Compatible dot matrix, letter quality, or laser printer

**Reprinted with permission by Software Digest from its July 1987 report covering 12 relational database programs.*

†Test was designed and executed by NSTL. A 1,000-record and a 10,000-record file were joined. A short text field from the 1,000-record file and a numeric field from the 10,000-record file were selected (using the 1,000-record file indexes). The short text field was grouped and sorted in ascending order, the numeric field was subtotaled for each group, and the results output to a null printer. Test times from the last keystroke on the command sequence until return of program control were recorded and averaged.


Paradox:
the top-rated
relational
database
manager
in the world...
PARADOX
Introduction
SINGLE OR MULTIUSER
2.0
RELEASE
Ansa

Paradox: the new corporate standard

Paradox automatically updates your data and lets you control access to information

In "Co-Edit" mode, changes made by anyone are automatically updated to everyone. You can pre-set a "Screen-Refresh" interval to occur anywhere from 1-second to 1-hour intervals. (If you don't make a preset choice, Paradox automatically updates every 3 seconds so that your screen always shows you updated data).

While Paradox 2.0 lets everyone share and update information simultaneously, you can configure it to keep secrets secret.

You can restrict others' rights in a variety of ways with safeguards protecting confidential files and/or giving someone "Read Only" rights which is to allow "View," but prevent "Change." The Paradox technique—automatic file and record locking—ensures data accuracy and integrity in any multiuser environment.

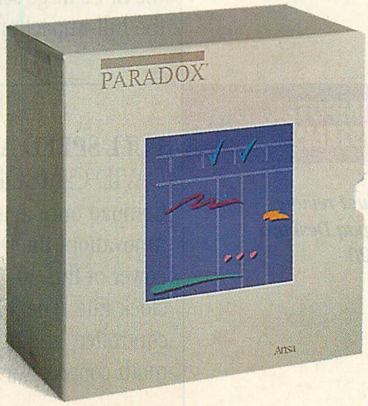
For a brochure or the dealer nearest you call (800) 543-7543

> "With Version 2.0, Paradox becomes a sophisticated multiuser product that boasts an impressive selection of data-protection features and password-security levels"
>
> *Rusel DeMaria, PC Week*

Get serious support for serious Paradox application programming

When you subscribe to the Paradox Developer's Resource Program (PDRP), you get all the resources and support you need for sophisticated Paradox application development: unlimited access to our toll-free PAL programmers support line; the Paradox Developer's Toolkit; a subscription to *Turbo Technix*, Borland's bi-monthly technical magazine; and a 20% discount on the Paradox User's Journal published by the Cobb Group.

Call our Customer Service Department at (408) 438-8400 for your free PDRP information kit with all the details.



PARADOX

by Ansa

A Borland Company

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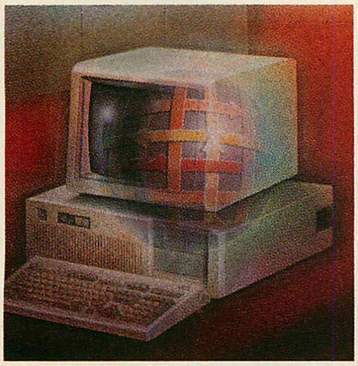
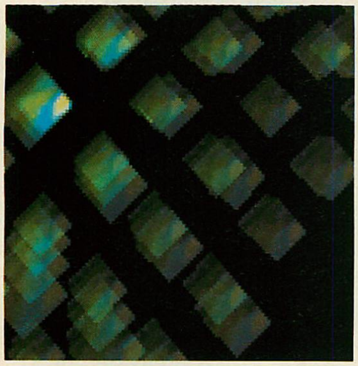
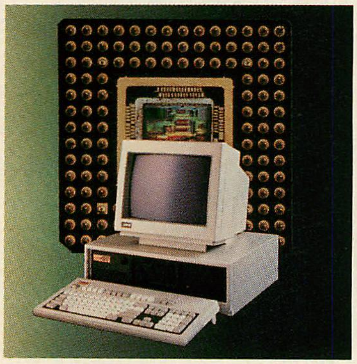
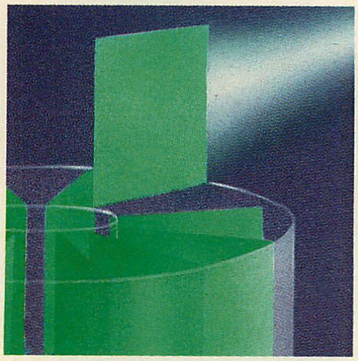
TECH PC JOURNAL

FOR SYSTEMS DEVELOPERS AND INTEGRATORS









COVER SUITE: PRESENTATION MANAGER

Still a blur on the horizon, OS/2's graphics user interface will take shape as it makes its way toward us over the next few months. Its potentially powerful impact demands our careful attention even in these early stages of its development. We take a look at current specifications and preliminary code to provide a glimpse into the future.

COMPUTER SYSTEMS

Product review: Compaq Deskpro 386/20

MAINFRAME CONNECTIONS

Product review: TAB

THE PC/IDMS ALLIANCE

ANDREW TOPPER

The Application Builder (TAB) from Online/Database Software brings the PC and mainframe one step closer together in the data management world. With TAB, a developer can use a PC to create a database application that can run on a mainframe supporting Cullinet Software's popular data manager, IDMS. Likewise, IDMS applications can run on a PC under TAB. 104

DATA MANAGEMENT

Product review: Advanced Revelation

COMPLEXITY MADE SIMPLER

KENT PHELPS

Revelation Technologies has released its third version of Revelation, called Advanced Revelation. The enhanced product adds a menu-driven user interface and streamlines its development tools. The result is a data manager that, like its predecessors, can handle complex applications, but now with very few complications for the developer. 122

SYSTEMS FORUM, PART 2

The 1988 installment of the *PC Tech Journal* Systems Forum will take place June 13–15 at the Westin St. Francis Hotel in San Francisco. An opening reception is planned for Sunday evening, June 12. The program itself begins Monday morning and ends at noon on Wednesday. We will follow the same panel-discussion format that was so well received during our first effort last September.

This year's panel topics will cover operating systems (an OS/2 update is certain), networks, data management, computer systems, software development, and host communications. Panel members will be a balanced mix of vendors and systems professionals. *PC Tech Journal* editorial staff members will serve as moderators.

To register for Systems Forum '88, or just for more information, please call 800/544-PCTJ or write to *PC Tech Journal* Systems Forum, Suite 800, 10480 Little Patuxent Parkway, Columbia, MD 21044.

By the way, enrollment is limited. That's not a gimmick: it's the truth. We are purposely limiting the size of the event to ensure the same intimacy and effectiveness that you liked so much the first time around.

—*WF*

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Cover illustration · Nenead Jakesevic

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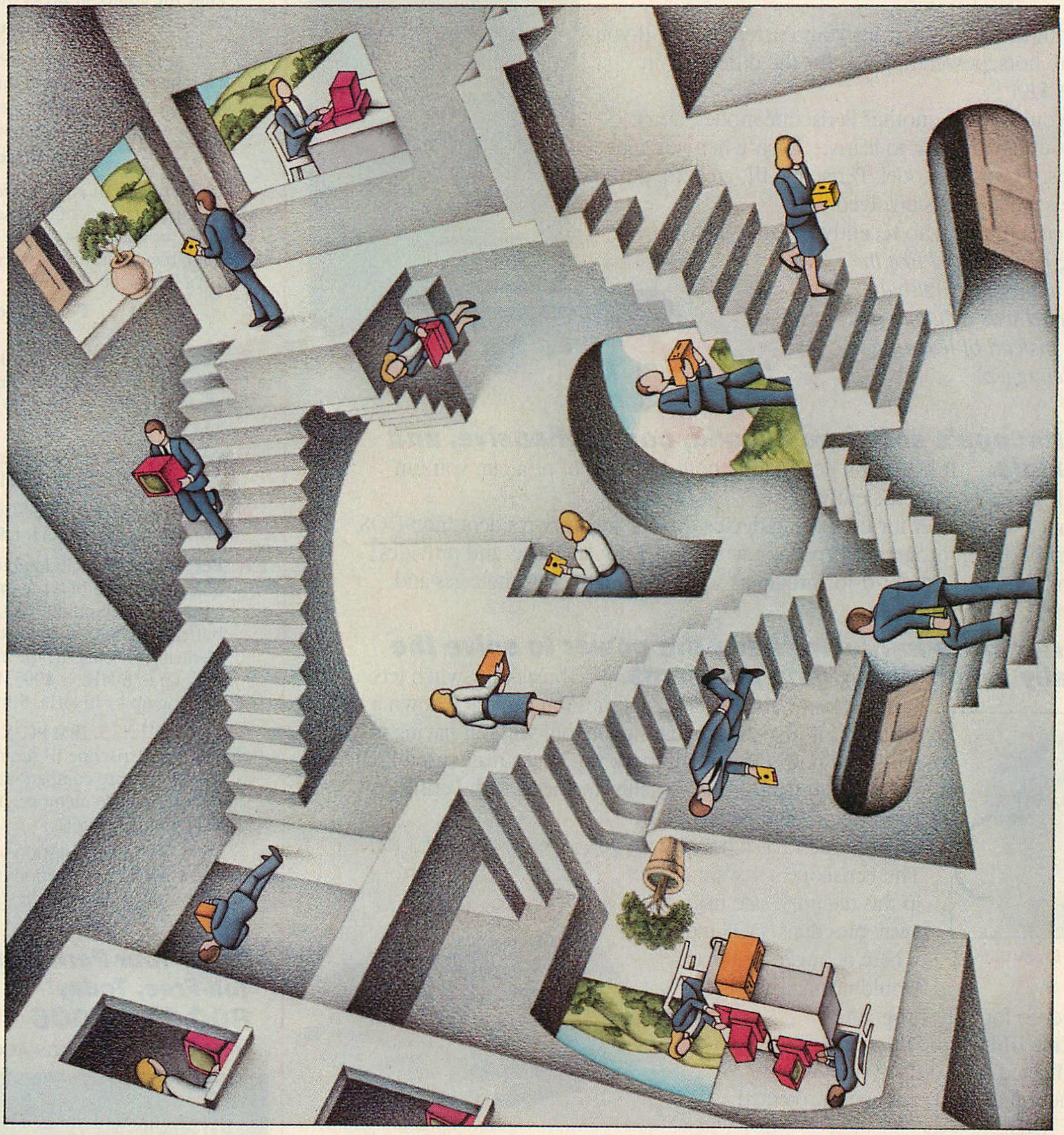
To Most of Us, Answers to Today's Perplexing Systems Questions Will Come in Time.



For 500 of Us, They Will Come on June 13-15. SYSTEMS FORUM 88.

Confusion. Conflict. Chaos. These are the spirits that create the questions of today's systems issues, and that make it tougher for you to predict what's going to happen tomorrow.

But in June, some of us will know more than the rest of us about what is happening now and what is going to happen.

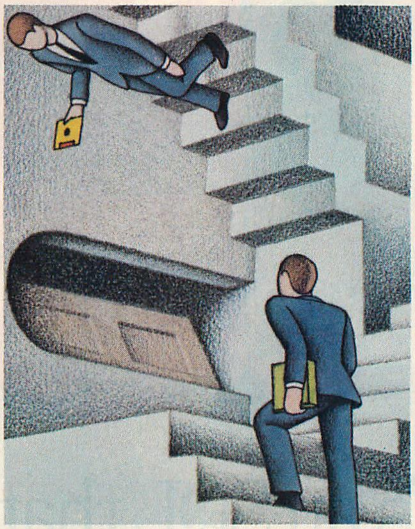
June 13 - 15 are the dates for the second annual PC Tech Journal Systems Forum in San Francisco. This is where industry leaders -- both vendors and users -- will gather to handle the industry's hottest topics, and to take some of the confusion, conflict and chaos out of all that is happening to PC systems today.

Last year, the first PC Tech Journal Systems Forum illuminated and impressed. The systems professionals who attended came away with the most expert and current information available. Some comments ... "One of the most relevant forums/conferences I've been to," and "PC Tech Journal did a great job. I especially like Will Fastie's Donahue approach as moderator."

And for 500 systems professionals, the PC Tech Journal Systems Forum 88 will be even more illuminating than in 1987. This isn't a lecture series; it's expert panelists and a professional audience, posing questions and seeking answers for business. You'll have your chance to explore the issues and problems that concern you most. Here's a sample of what you'll encounter at PC Tech Journal's Systems Forum 88.

1. OS/2: Out of the Starting Gate. Now that it's out, where is it going? What is the state of software for OS/2? Do we have the right tools -- and enough of them?

2. Toward the 386 Platform. Is the 386 just a faster 286? Or is it opening up new desktop applications? What will falling 386 prices do to the sale of 286 and 8088/86 machines? Will a 386 add-in board give you a full-fledged 386 machine?



3. Bus Wars. Who will win the war for bus supremacy -- IBM's Micro Channel, the "classic" PC bus, or AST's new SmartBus? Will one emerge as the standard? Which one? What does that mean to you?

4. Meeting the Needs of the End User. Today, with centralized control taking the "personal" out of "personal computer," what do end users need? How do they get it? How are other important issues, such as training or software updates, handled?

5. SQL: A Midterm Report. Now that it appears to be the standard, what must systems managers know about SQL to deploy distributed systems? Is SQL the only answer?

TECH PC JOURNAL
Systems Forum '88
SAN FRANCISCO

6. Developing Applications for the Graphical User Environment. The Macintosh is here and the Presentation Manager is on the way. Are these new environments the basis for new solutions or more problems? Do the environments provide enough function for the typical developer?

7. At the Desktop: A Hardware Melting Pot. What software and systems issues are created by the typical melange of IBM compatibles, workstations and Macintoshes found in the workplace?

8. Managing Your Network. In the growing world of LANs, how does the manager plan for administering them now and project resources necessary to manage them over time?

9. The Network API Supermarket. With all of the application programming interfaces (APIs) available today, which one should the developer choose? How much is the choice affected by the network software? Is there a standard? And if not, do we need one?

10. Networking Networks. If managing one network is a challenge, how do you manage a network of networks? How are they connected? How are the hardware and software in each LAN integrated with the others?

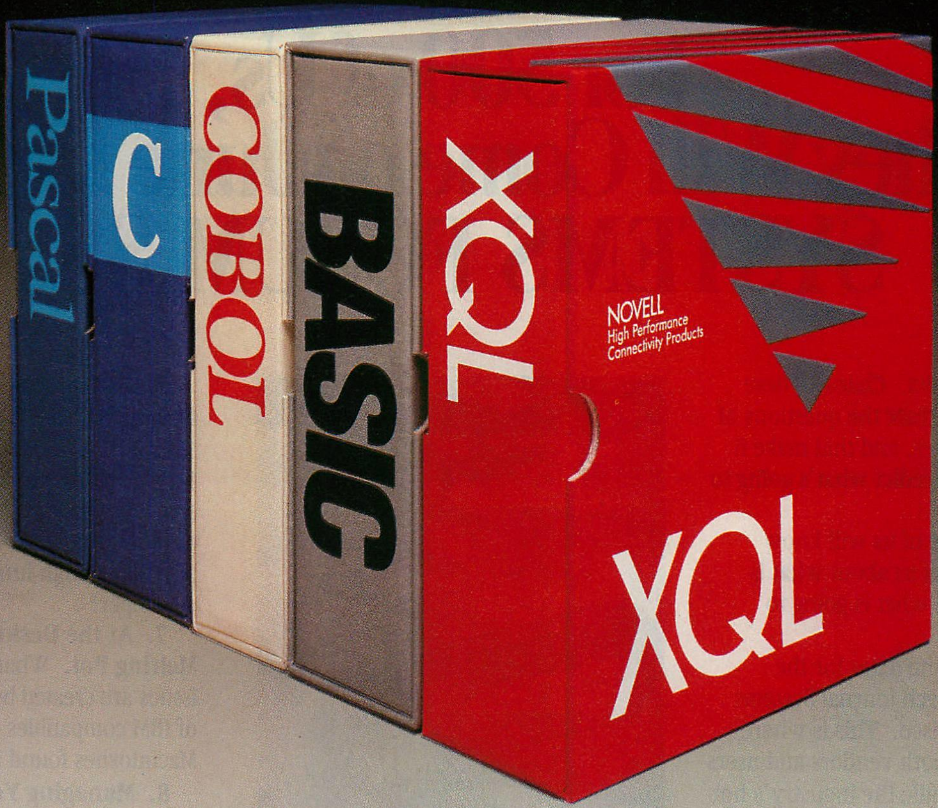
The PC Tech Journal Systems Forum is a working meeting -- a place where professionals learn from professionals. Because of that, registration is limited to 500.

The cost for the three-day forum is \$ 795 (\$ 695 if you register before April 15). Ask for special PC Tech Journal rates at the Westin St. Francis, the official forum hotel, by calling 415-397-7000 or Westin national reservations at 800-228-3000.

Register now, and get ready for the most enlightening and most important PC meeting of the year -- beginning June 13.

To register or for further information call

800-544-PCTJ.



Finally, there's an SQL that gets back to BASIC. And COBOL. And C. And Pascal.

As a programmer, you've probably already faced it—the database dilemma. Do you use an SQL for easy database handling, or a true programming language for maximum power and flexibility?

Now you can do both with XQL,® the relational data management system from the developers of Btrieve.®

The Programmer's SQL. With XQL, you can access your data with the ease of Structured Query Language through simple subroutine calls from traditional programming languages. XQL supports standard SQL syntax, including subqueries, unions and security groups.

XQL Relational Primitive Operations. In addition, XQL lets you bypass the SQL level and perform highly efficient, relational primitive operations directly. You get all the functionality of a relational database model without the constraints of a 4th generation language.

Building on Btrieve. The heart of Novell's family of data management tools is Btrieve. By letting you access multiple records at a time, XQL adds a powerful dimension to Btrieve. XQL incorporates sophisticated data manipulation features which allow you to access data by field name, move forward or backwards through the database, compute fields from other fields or constants, and even work with composite records built from multiple, joined Btrieve files.

Like Btrieve, XQL offers features like multi-user support, fault tolerance, comprehensive documentation, and expert technical support. And you never pay royalties on your XQL applications.

Solve the database dilemma with XQL, the SQL that speaks your language. Only $795.* See your Authorized Novell Gold Reseller, or call us at (512) 346-8380.

For more information, call from your modem 1-800-444-4472 (8 bit, no parity, 1 stop bit) and enter the access code NVXQL3.

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For software solutions, you should be seeing red.

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Requires Btrieve 4.x and PC-DOS or MS-DOS 2.x, 3.x.

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SYSTEMS PERSPECTIVE

More than Window Dressing

The Presentation Manager may forever change our way of looking at data.

Later this year, the much anticipated Presentation Manager is due to appear, perhaps changing the way we look at future applications. Because of its complexity and potentially powerful impact, we believe it necessary to provide as much detail as we can as early as possible.

So consider this month's cover suite your sneak preview of this product, Microsoft's and IBM's cooperative effort to promote a standard graphics user interface for applications. Implemented as a set of dynamic link libraries for OS/2, the Presentation Manager provides an optional application program interface (API) for developers wishing to incorporate windowing, pull-down menus, and presentation graphics into their applications.

The Presentation Manager takes on more significance because it forms the common user interface component of IBM's Systems Application Architecture (SAA). This means that in the long run, applications written to the Presentation Manager's API will be portable to other machines and operating environments embracing the SAA standard. We will cover SAA in detail next month.

At the time we prepared this issue, the Presentation Manager was still in the embryonic stage. Our authors worked with IBM and Microsoft specifications and preliminary code. We are presenting the specifications as they have been defined thus far, but be aware that these specifications may change before the product is released in the fourth quarter of this year.

The first article in the cover suite, "Projecting a Graphics Interface," sets the stage. Author Ed McNierney introduces the Presentation Manager and puts it into perspective—what it is (graphics program interface, window management, and video I/O), and what benefits a consistent and standard user interface delivers to both users and developers. "The User at the Controls," also by McNierney, explores the Presentation Manager's user interface and supplied utilities in more depth. In "A Consistent API," Michael Bentley describes the functions available in the Presentation Manager's application program interface.

In a related discussion, editorial director Will Fastie analyzes Microsoft's Excel as a prototypical application illustrating how the Presentation Manager concept can be used. First introduced for the Apple Macintosh, Excel was adapted to run under Microsoft Windows. Microsoft drew upon its roots in the Macintosh world to create this spreadsheet—with its graphics user interface—for the PC.

Developers who have built Windows applications will be familiar with the basic concepts of developing a Presentation Manager program. Wherever it is possible, throughout the cover suite of articles, we compare and contrast the Presentation Manager with Windows. However, some of the user interface and much of the API changed as the Presentation Manager evolved, with IBM's help, from the philosophy of Windows.

The Presentation Manager and OS/2 together have the potential to fulfill the promise that Windows was unable to realize. The multitasking and other operating system components of Windows-built-on-DOS have migrated to OS/2, leaving only the presentation graphics and user interface shell in the Presentation Manager.

A user interface, which essentially is the conversation between a program and user, is composed of many elements. The Presentation Manager specification proposes strategies for handling each aspect of the conversation—this includes managing physical devices such as the display, mouse, and keyboard, as well as the logical communication between user and program from opening to closing handshake. One improvement of the Presentation Manager over Windows is a more facile use of the keyboard, making the mouse a less crucial accessory.

For example, say a user needs to command a program to perform a particular function. The Presentation Manager convention calls for the major categories of commands to be placed across the top menu bar. Minor commands within each category are accessed through pull-down menus. To retrieve a file, the user would first choose the File command from the top

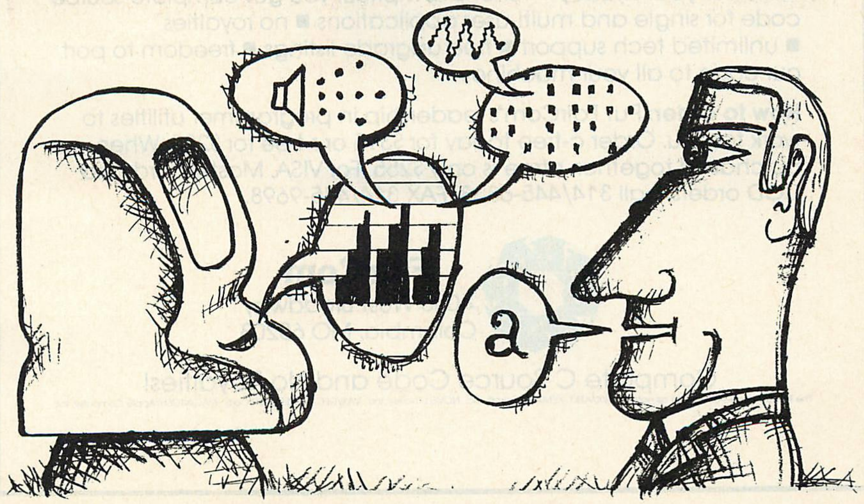

ILLUSTRATION • MACIEK ALBRECHT

menu line, thus opening a pull-down menu from which he chooses Retrieve. Pop-up dialog boxes are used when the program needs to ask questions of the user. In this example, the user would type the name of the file to retrieve in the dialog box.

To a power user with a mouse, this may sound like a lot of work. The keyboard interface, however, allows the use of Alt-key combinations for choosing menu items, which can speed the selection process. The point is that no matter what application is being executed, the procedure for retrieving a file should be the same.

This consistency of the user interface from application to application is beneficial not only because it eliminates the need to master a different expert interface with each new application, but also because it takes on critical importance with the advent of OS/2. With true multitasking, the user will be communicating with multiple applications at the same time. How much nicer it would be to speak to all programs in the same language.

The Presentation Manager, however, encompasses more than operational commands. The API provides functions for device-independent presentation of graphics output on the screen or printer. Device independence is a great advantage for a developer, who no longer needs to write multiple output routines or drivers for each display or printer device. Even text-based applications can benefit from the ease with which the Presentation Manager can display variable text fonts.

A graphics user interface should benefit any program that communicates with the user through a display device. (This eliminates drivers and other such applications with program-to-program or program-to-machine interfaces.) Most of today's applications are text-based, mainly because, having been limited by hardware, we have reduced the graphics world to a textual representation. Similarly, during the early days of the PC, we reduced the color world to monochrome.

We need to rethink our assumptions about the presentation of data. Microsoft's Excel is a good example of a traditional text-based application—namely a spreadsheet—being enhanced and made more approachable through a graphics interface. Such an interface should not be thought of simply as window dressing, but as an effective method for communicating meaning and substance to the user.

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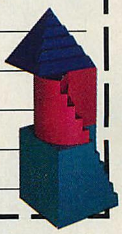

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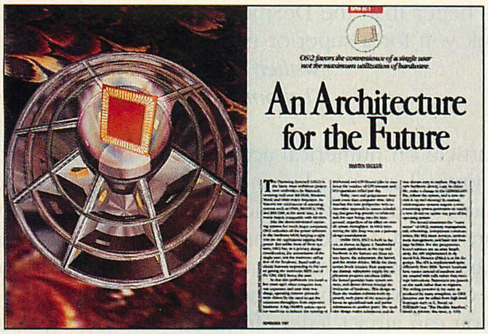

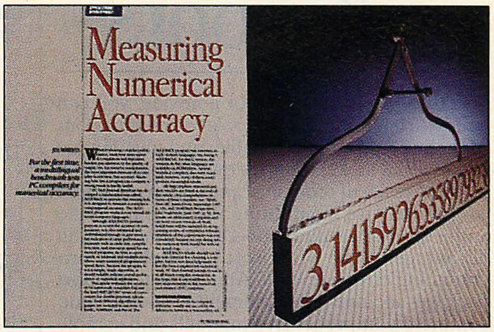

RIGHT AND LEFT

I have a note of interest on the November 1987 article by Martin Heller on OS/2 ("An Architecture for the Future," p. 66). In figure 2 of the sidebar ("How Protected Mode Protects," Ted Mirecki, p. 80), the Segment Descriptor Format is technically inaccurate. Limit should be lowest, and Reserved should be highest in memory; that is, it should read from left to right (low memory to high memory) Limit, Base, Access, and Reserved. This was probably picked up from the Intel documentation, which has a visual representation that, at first glance, might suggest that Limit is higher in memory. However, if you check the offsets in the margin, it is at offset 0. In addition, in the caption to figure 3 of the sidebar, bit 3 should correctly read bit 2.

In the article by David A. Schmitt ("The Flexible Interface," November 1987, p. 110), I would like to point out an error. The author states (p. 116) that "Arguments are pushed onto the stack in right-to-left order . . . (the standard C sequence pushes arguments left to right);" in fact, arguments are pushed onto the stack left to right, and standard C pushes right to left.

Reed Meseck
Irvine, CA

Protected-mode segment selectors, like all fixed-length multibyte data structures handled by Intel microprocessors, are stored in memory in reverse order—the byte that is logically first is stored at the highest address, and the last byte is stored in the lowest address occupied by the structure. Figure 2 of the sidebar shows the logical ordering of bytes, not the physical offsets in memory. This is a well-established convention; for instance, 8-byte reals are always shown with the high-order byte containing the sign and exponent at the left, even though the offset of that byte is the highest.

Mr. Meseck's other two observations are correct. The table selector bit is incorrectly identified in the caption for figure 3, but it is correctly labeled in the figure itself. The statement about the argument order was inadvertently reversed in the editorial process. We apologize for any inconvenience these errors may have caused.

—TM

IMPORTANCE OF ACCURACY

Thank you very much for publishing the important article on "Measuring Numerical Accuracy," by Jim Roberts (January 1988, p. 142). This topic has been neglected too long and at too much cost to those doing numerical calculations. The program ACCURACY is a major step forward.

On a 4.77-MHz V20-equipped IBM PC, version 2.4 of the C Ware DeSmet compiler compiled and executed ACCURACY.C in 55.1 seconds (actually, a modified version, but the changes were trivial) and executed it in 9.9 seconds. Comparing the figures given for C Ware in table 4 of the article (p. 150), it would seem that the time of 37.3 given for the execution must be wrong. Could it have been 3.7 seconds, or 7.3? This fact is pertinent because it calls into question the conclusion that the compilers with the worst accuracy performance also have the slowest execution times. In particular, the DeSmet compiler appears to achieve its speed at the expense of accuracy—a trade-off that, in theory at least, may be a legitimate alternative.

On this computer, ACCURACY gave a value of 0.94 for the arctangent series. This contrasts with a published value in table 3 of 0.04. I suspect this was a typographical error. (Is Turbo C really that much slower than Turbo BASIC and Turbo Pascal?)

My most serious concern is that you may have published the overall results in a form that ensures they may never have a significant impact on compiler developers. A nontechnical or casual reader of tables 3 and 4 would likely come to the conclusion that the major differences among the compilers are in speed, not in accuracy. The error-rating value, although it is mathematically a useful number, tends to obscure the magnitude of the variations in accuracy it measures. Anyone who understands logarithms can understand the error rating.

My fear is that this probably excludes everyone who has the power to commit the dollars necessary to improve the compilers that are hamstringing the powerful NDP. I think those people will find the difference between 0.80 and 0.30 to be trivial. But if you explain that the difference represents a factor of 3, then I think that would motivate action; action that is sorely needed to exploit the power of the NDP. You also did not mention that the NDP is of a vastly superior design to both the VAX and the IBM 360 floating-point facilities so that it is a sad irony that PC compilers are getting worse results from a system that was carefully and laboriously crafted to provide nearly perfect results.

I think you could remedy the problem by adding only one line to table 3. Pick the worst compiler and arbitrarily assign it a value of 1. Then express the others as being a certain factor better than that. For example, make DeSmet 1, corresponding to its error rating of 1.52. Then Microsoft C becomes 10 ^(1.52 − 0.79) = 5.37 better than DeSmet, and VAX/UNIX FORTRAN becomes 10 ^(1.52 − 0.28) = 17.38. Thus anyone at C Ware can see at a glance that Microsoft's compiler is five times more accurate than theirs. Similarly, the people at Microsoft can see that it will take some work to close the gap between 5 and 17, let alone the inherent capability of the chip, which I guess is in the vicinity of 30

times better than the DeSmet results. (Thank you for a superior magazine.)

Walter I. Nissen, Jr.
Takoma Park, MD

The article on numerical accuracy in your journal is a good example of practical research from which many of us can benefit. However, the article appears to contain some inaccuracies of its own (maybe that is the only way that you can attract letters from busy programmers).

The 88.0-second execution time that is listed for the Turbo Pascal 3.01 seemed unreasonably high; so I downloaded ACCURACY.PAS from PCTECHline and found that the 20 iterations took 30 seconds on my 10-MHz AST. Making an adjustment for the faster machine, it seems the correct time should be about 41 seconds.

Probably the 88.0 is a typographical repetition of the compile time for Oregon Pascal on the line above. What an insult to venerable Turbo Pascal 3.01 that, in its time, has produced some of the fastest code ever seen from any PC compiler!

Incidentally, Turbo Pascal 4.0 runs ACCURACY 20 times in 17.5 seconds on my AST (adjust that to about 24 seconds for comparison with the times in the article). And it compiles and links in about 2 seconds. Furthermore, version 4.0 yields an overall accuracy figure of 0.79—which is about as good as they come. (Try typing real as "extended" in Turbo Pascal 4.0 if you want to see precision.)

Finally, I want to share with you a different perspective on the term "serious numerical work;" namely, that "serious" and "accurate" do not necessarily mean "17 digits."

Most of the measurements done in the real world involve quite low actual precision—say, about one part per thousand. Many computations can be done with such numbers using 4-byte floating point or even 4- and 2-byte integers. With careful programming, highest performance may be possible without using the math coprocessor at all, since the 80-bit real is such a vast overkill. Yet these applications are certainly numerical, may be quite serious, and are perhaps more common than those requiring high precision. The 80x87 is not the sine qua non of the numerical PC. It is the easiest way to program, but not necessarily the way to make the best program.

A case in point is my General HydroStatics system that models ship hulls and computes their hydrostatic-stability characteristics. It performs volume and moment integrations in vast quantities but certainly does not require more than single-precision reals. In fact, the geometrical representation is best done with 2-byte integers, scaled appropriately. This program, which embodies seven separately compiled modules, is written in Turbo Pascal 3.01, makes extensive use of integers, does not use the coprocessor, and has excellent performance. Quite an achievement, I think, for a compiler that the author claims is "too confining for major computational efforts."

William A. Plice III
Creative Systems
Seattle, WA

I thank Mr. Nissen and Mr. Plice for their kind remarks on the intent of the article on numerical accuracy, if not the detailed execution.

There are so many differences between Mr. Nissen's DeSmet C runs and mine (different compiler version, different hardware, and different program) that the origin of all the variations that he observes is not crystal clear. He may have missed the fact that the execution times shown in table 4 are for a form of the ACCURACY program with all output statements removed and the computations given 20 iterations. This was done to look at raw compute speed. All timing was done by hand from DOS prompt to DOS prompt. The compile and link times in the same table are for the published version of the program. I no longer have version 2.4 of DeSmet, since version 2.51 was a considerable improvement. The V20 chip speeds up the NDP-assisted computations by about 10 percent.

Both readers spotted misprints in tables 3 and 4. These were inadvertently introduced during the production process. The correct values are as follows: in table 3, the DeSmet C arctangent test, error rating should be 0.94; the Turbo Pascal continued-fraction test, error rating should be 1.17. In table 4, the Turbo Pascal execution time should read 42.0 seconds. I especially regret this last error because it makes Turbo Pascal look bad, and Borland engineers were helpful to me.

I thank Mr. Plice for his useful remarks on Turbo Pascal 4.0; this version was not available when the article was written.

Yes, Mr. Nissen, Turbo C compiled much more slowly than Turbo BASIC and Turbo Pascal. It also produces

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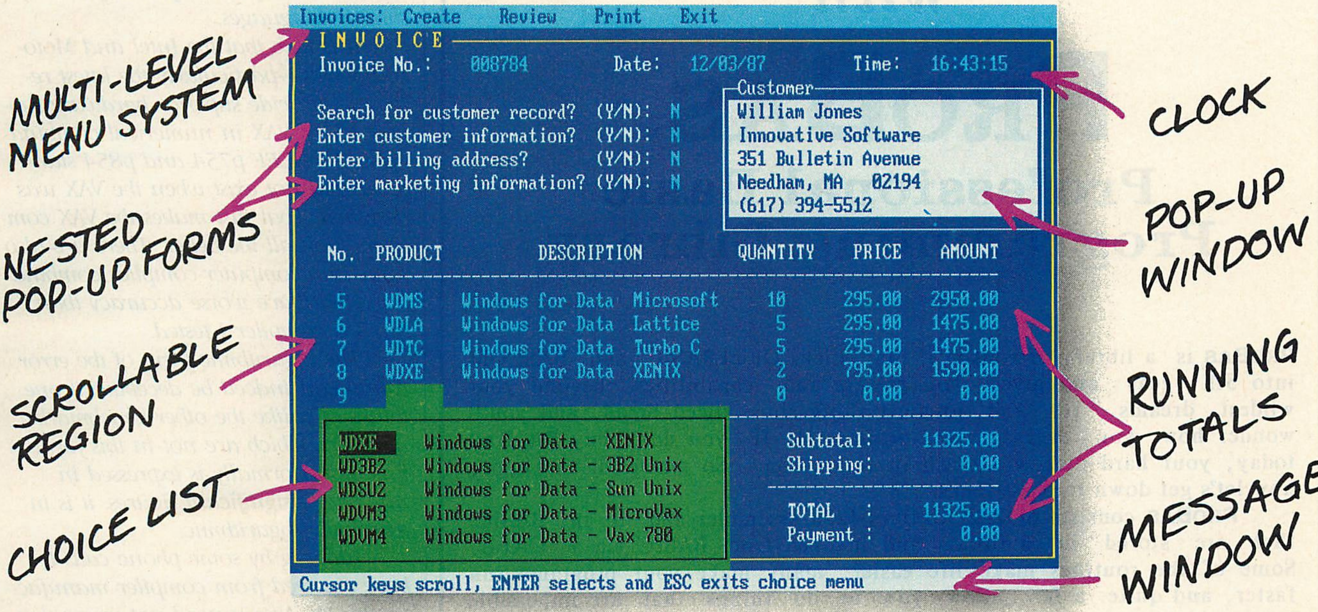

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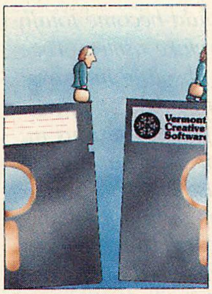

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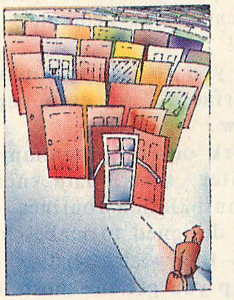

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much better code. The listed compilation time also includes the link step, which is not used by Borland's Pascal and BASIC compilers. C's preprocessor step probably makes it impossible to write a C compiler as fast as for the simpler languages.

It is true that the Intel and Motorola NDPs—particularly the latest releases—provide superior hardware support to the VAX in numerical computations. The IEEE p754 and p854 standards did not exist when the VAX was designed. That just makes the VAX compilers look all the better. There are also some minicomputer-compiler combinations that have worse accuracy than any PC compiler I tested.

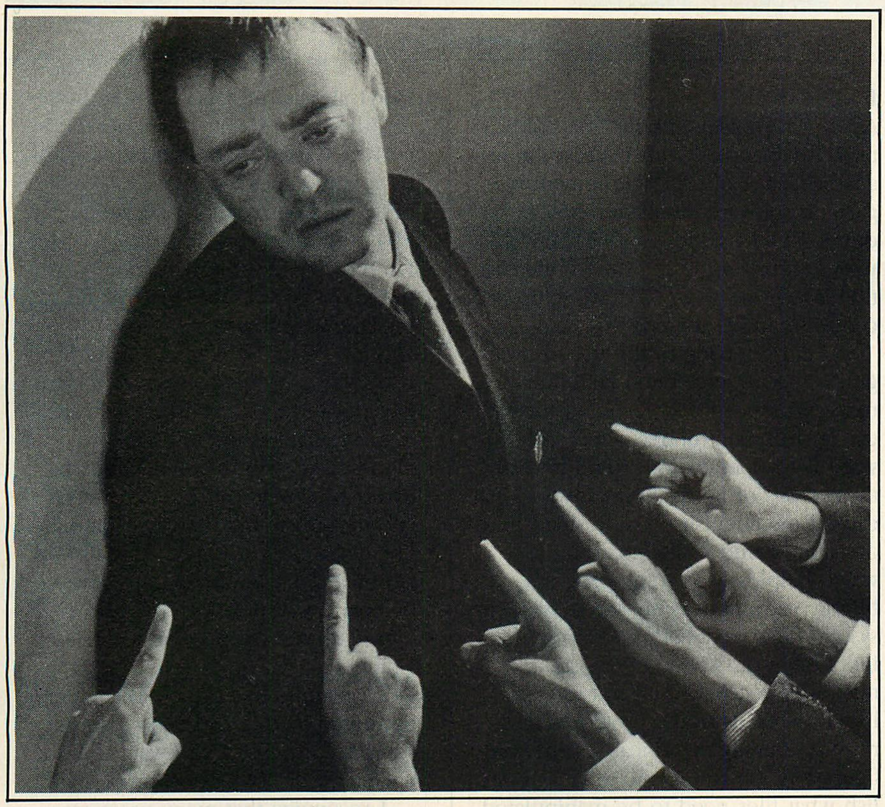
The logarithmic form of the error rating can indeed be deceptive if one thinks of it like the other benchmark numbers, which are not in this form. Precision normally is expressed in number of significant figures; it is intrinsically logarithmic.

Judging by some phone calls I have received from compiler manufacturers, Mr. Nissen need not worry that the manufacturers of well-supported compilers will ignore any published benchmark, especially if it makes their compiler look good. There are some pretty bright folks out there working on compilers. They know about logarithms.

I am not totally happy with the form of the error rating, nor with its unevenness from test to test. ACCURACY went through a few iterations; probably it will have to go through some more if it is to be accepted.

However, I believe that it would be a serious mistake to follow Mr. Nissen's suggestion of making the error rating relative to the performance of a particular compiler. That compiler manufacturer could make a tiny change and render obsolete all published ratings. The benchmark would become totally confusing and therefore useless. The rating must be an absolute measure that is independent of the compiler.

My use of the phrase "serious numerical work" seems to require some clarification, because Mr. Plice's interpretation is that computing the moments of a complicated, but well-defined, three-dimensional object can be so described. A lot of numbers should not be confused with numerical analysis. Drawing the Mandelbrot set also involves a lot of numbers, but the math is trivial. Mr. Plice also recognizes that integers often can do the work of reals, and do it faster. Surprisingly, the Mandelbrot set also can be computed



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much more rapidly with integer arithmetic than with the NDP.

"Serious numerical work" means to me, for instance, the solution of simultaneous systems of differential equations, particularly space-time systems, finding accurate eigenvalues and eigenvectors for sometimes nasty matrices, and solving sparse matrices, which are involved in geodesy and in the accurate computation of orbits of satellites and spacecraft. In all these problems, one wants not only as long a word length as practicable, but also well-behaved mathematical functions that are monotonic on the smallest granular scale of the numbers used.

I would like to take this opportunity to correct a misstatement in the article concerning the relationship of the IEEE to the Paranoia program. I had the impression, at first, that IEEE was sponsoring this collection of tests for the adherence of compilers to the IEEE P854 standard. This is not so: IEEE has not commissioned this evolving public-domain program, and has no official relationship to it. A number of versions of Paranoia are available; however, no one version tests the entire IEEE P854 standard.

—Jim Roberts

BLIND FAITH

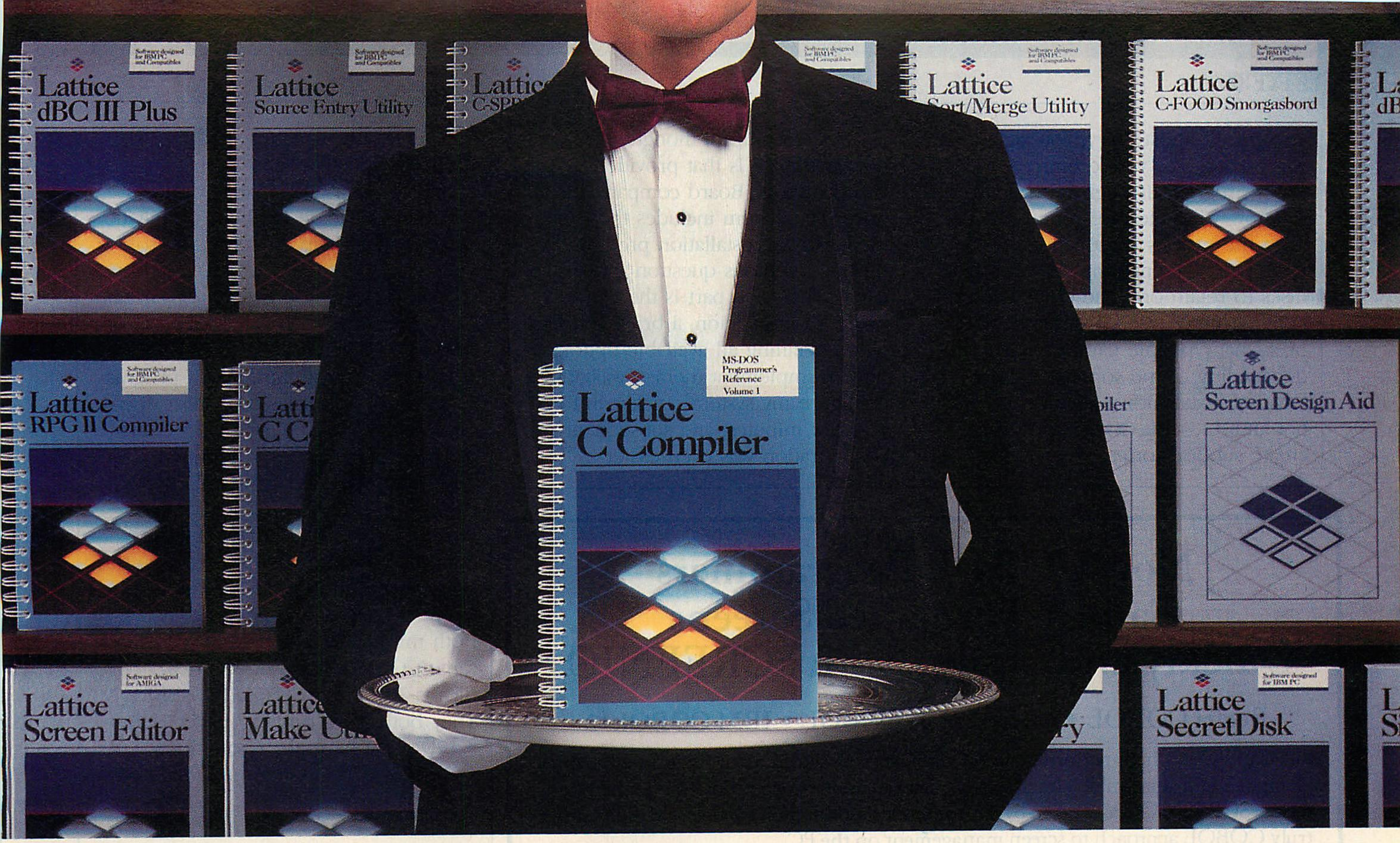
As an avid reader of your fine publication, I have noted with interest the relative absence of critical comment regarding software-installation procedures. I feel compelled to present my views on this topic, with the hope that the current trend in software-setup procedures can be altered.

I am referring to the use of programs that require blind faith and make gross assumptions about the target environment under which the software is to operate. The trend toward these types of installation processes has caused me anguish on more than one occasion. I find it disconcerting to watch helplessly as some program blindly reconfigures my carefully set-up system files, frequently rendering them inoperable or, worse, nonexistent. I make this request of all software publishers who distribute programs that require lengthy or critical system configuration; explain to me in clear English what files need to be manipulated and in what way. Then, just allow me to look after this task, so that it can be accomplished without disturbing my existing configuration.

I offer these additional suggestions to the software publishers:

- Don't always rely on video hardware or other peripherals to supply the correct system-configuration information. Sometimes a minor incompatibility causes erroneous decisions about installed equipment.
- Do give files meaningful names. Let me know how a particular file fits into the overall system.
- If setup procedures must be automated by a program, document what is supposed to occur in enough detail to verify correct operation.
- Don't make assumptions about what drives or directories I want to use. Let me decide the directory names.
- Do allow me to install a no-frills version if I don't always need all the bells and whistles.
- Please do not beep at me for every single little thing.
- Don't assume that the entire system is dedicated to one particular software package, and that I will want to boot up into your application program.

I recognize that many users are dependent on automated installation procedures, and I applaud publishers who have done a good job of providing this facility. However, many times, novice users rely on expert help when problems arise, and it can be crippling



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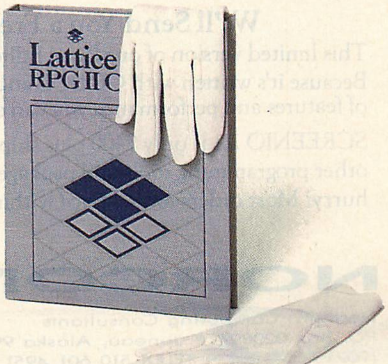

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to even the most savvy troubleshooter when control is vested entirely within a setup program. It often is advantageous to know what files are required to perform the various subfunctions of a large package, enabling crowded hard disks to retain only the crucial components of much used programs. Moreover, many people gain a deeper understanding of the software by performing installation manually and are not afraid to edit CONFIG.SYS files, create subdirectories, or copy files.

An example of thoughtful installation assistance is that provided by Intel with its Above Board companion software. The system includes the usual menu-driven installation program, requiring a tedious question-and-answer game. The good part is the *Hackers' Guide* to installation, a brief, concise guide detailing all available options and how to implement them. I was able to configure my system quickly and easily in a few minutes, and subsequent reconfiguration was even easier.

As PC users mature, so must their tools. A mature product's function is accessible to a broad range of users' capabilities. Please let those of us who would rather help ourselves, do so.

Rod Nussbaumer
British Columbia, Canada

MISLEADING PERFORMANCE

I have been using the ATDISK program to measure performance of disk drives. On a PS/2 Model 60, 40MB drive, the track-to-track seek time is shown as 5.9 ms. The Model 80, 20-MHz, 115MB drive gives a seek time of 13.4 ms. Since the Model 80's drive is faster than that of the Model 60, how can this be? I also found this to be true in many of your published benchmarks. Both machines were booted with the same CONFIG.SYS (buffers = 20, files = 20) and no AUTOEXEC.BAT. They both were running under DOS 3.3. Do you have any suggestions?

Paul Humenansky
Lombard, IL

The 70MB and 115MB disk drives used on the Model 80 use an ESDI disk controller. The ESDI controller must provide incorrect information in the disk table about the number of sectors, heads, and cylinders on each disk in order to calculate a correct relative disk block address from the information provided by a DOS function call. On a 70MB disk, track-to-track tests using DOS function calls step the head across about eight tracks at a time instead of one, resulting in larger than expected track-to-track access times. For additional information, see "Model 80: Performance and Potential," by Steven Armbrust and Caroline Halliday (August 1987, p. 138).

—JS

ONLY SKIN DEEP?

I was disappointed by the recent review of Windows for C and Windows for Data from Vermont Creative Software (Product Watch, December 1987, p. 197). My disappointment stems not from the reviewers' evaluation, which was generally favorable, but from the superficial nature of the review, which never got deep enough to convey to the systems professional what is special about our products.

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and install his or her own field type that behaves exactly as needed.

Windows for Data leaves the programmer in control at all times. Control functions that the application programmer writes and attaches to fields and/or keys can read, compare, validate, and change the data values of all fields in a form while the form is being processed. A control function can be called automatically at the beginning and/or the end of processing each field. Control functions can be used to call up subsidiary forms and menus, change fields, change field values, exit or abort the form, and so on.

Windows for Data handles all user interaction via key functions installed within a key table. The application programmer can revise and add functions to the key table at any point in time; thus the programmer can offer special options to the user at any point in the processing of the form.

The menu system of Windows for Data was omitted from the review entirely. The menu system allows all popular forms of menus to be implemented, with the same flexibility found elsewhere in the system. Pop-up menus can be automatically sized and placed by the system, but the programmer can take charge of these functions when necessary. Forms and menus can be nested to any desired level. Forms can call menus and vice versa.

Vince Taylor, president
Vermont Creative Software
Richford, VT

Windows for Data does indeed include a menu system that was neglected in the review. A simple menu function also is included in Windows for C. We are considering an in-depth review of C screen management libraries for an upcoming issue.

—DM

GOOD COVERAGE

Kent Quirk's article,"Accelerating to the 386" (January 1988, p. 108) presents a thorough overview of upgrading existing computers to the 80386. This letter clarifies some technical and business points Kent mentioned.

With regard to the memory subsystem, Inboard moves the motherboard memory to extended memory and replaces it with faster 32-bit memory. With respect to the software, Windows 386 2.03 does, in fact, run on Inboard 386. The Windows setup program and documentation do mention their support of the Inboard.

Customers can call Intel Literature at 800/548-4725 to obtain current technical documentation on the 80386.

Intel applauds Kent for his coverage of this critical topic.

David M. Taylor
Intel Corporation
Hillsboro, OR

COMMENTS WELCOME

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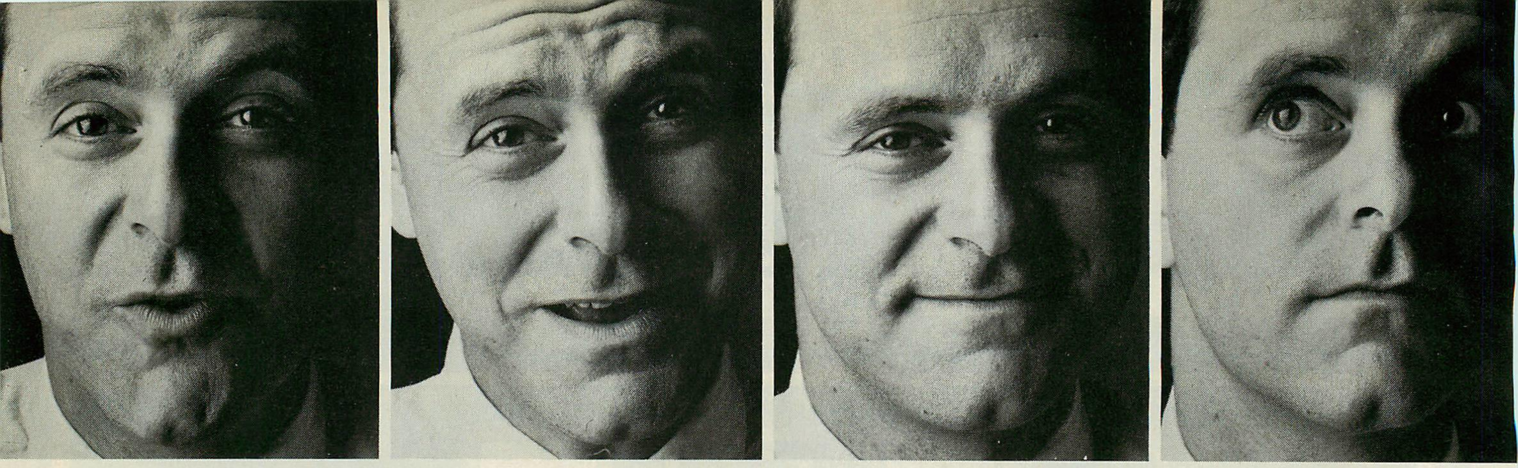

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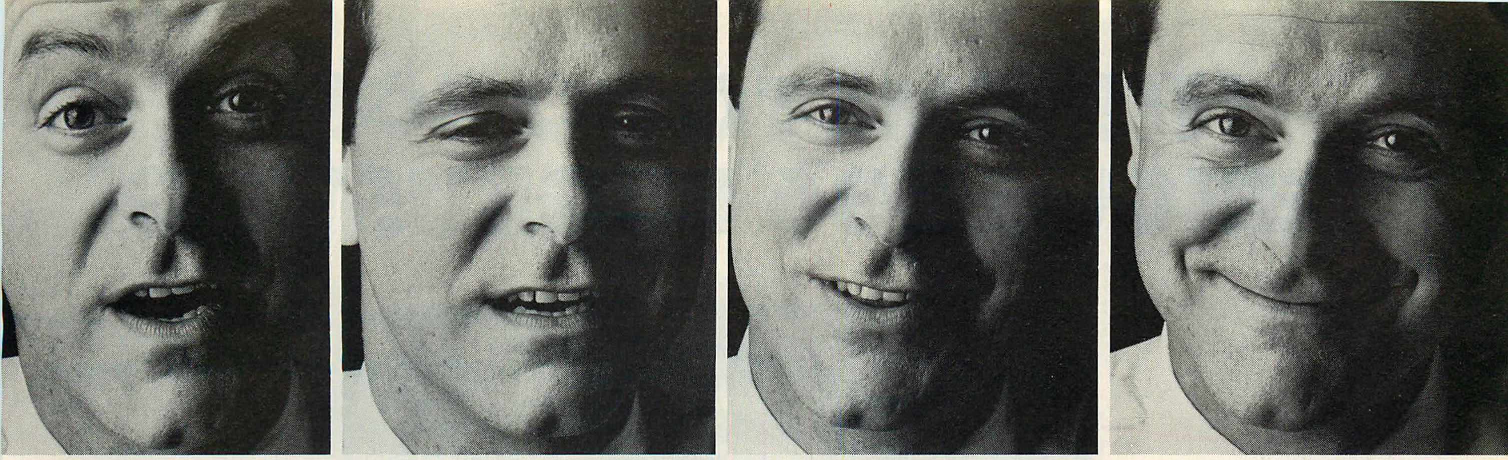

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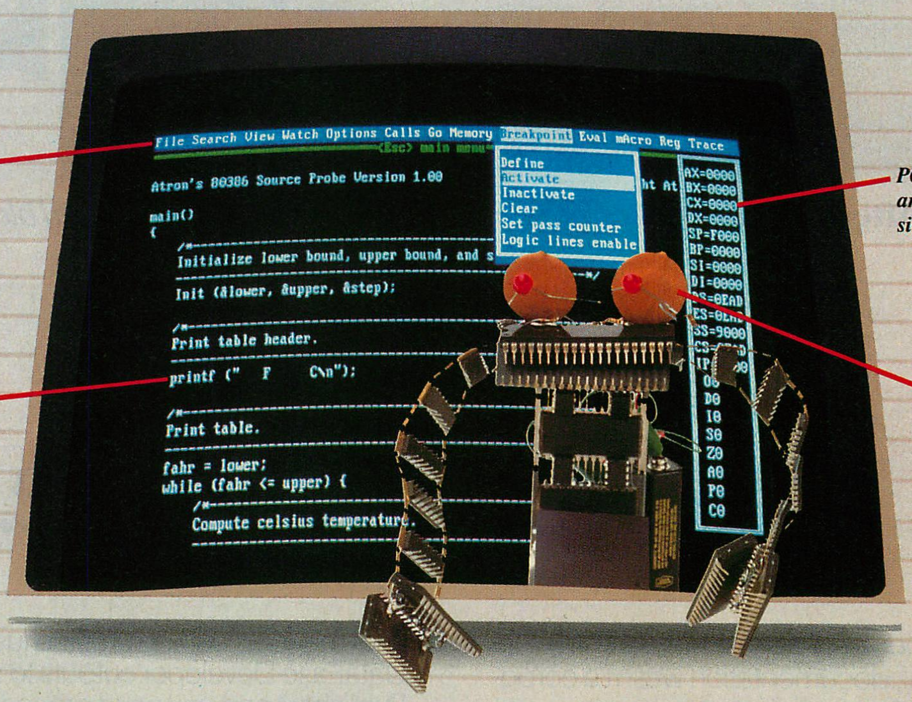

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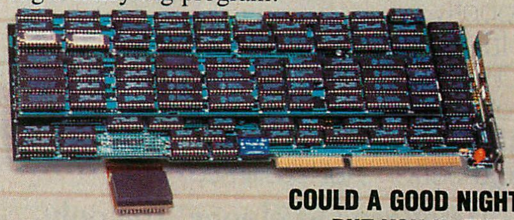

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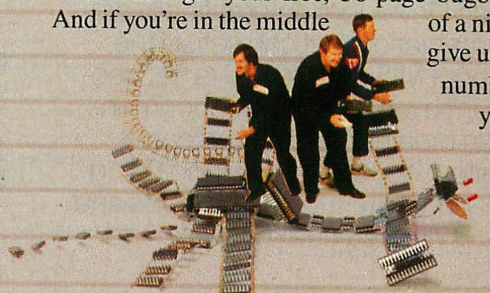

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WILL FASTIE

Excel Forecasts the Future

Microsoft's Excel gives us a glimpse of what the applications environment will be like under the Presentation Manager. □ Also, Quattro and ClickStart deserve mention. □ And, ALR produces a 20-MHz clone.

Although the arrival of OS/2 1.0 is an important step for the IBM-compatible world, in its present form it does nothing to combat the inroads Apple is making with the Macintosh in the business world. IBM's weapon against the Mac is yet to come: the Presentation Manager, not scheduled for release until October 1988. Until then, IBM and others are handicapped in the fight against Apple, especially when the issue is user interface, training, or presentation-quality graphics.

The critical question is whether the Presentation Manager will successfully compete against the Mac environment. At this time that question has no easy answer because any comparison is of an extant, market-tested product versus a product that is defined and specified but, as yet, nonexistent. We can see today, firsthand, what the Mac can do; however, we can capture only hints of the Presentation Manager's capabilities by assuming that Microsoft Windows is its prototype.

One product available today for both the Mac and Windows (and almost assuredly for the Presentation Manager when it debuts) offers a preview of the applications environment under the Presentation Manager. That product is Microsoft Excel. Even if you don't care about Excel as a spreadsheet, you should look at it carefully with a view to the future.

My intent is not to argue the merits of Excel over, say, Lotus 1-2-3; rather, I want to point out what sets it apart from other contemporary spreadsheet products, especially where those features are important to understanding the Presentation Manager.

First, of course, Excel is a spreadsheet product. Originally developed for the Apple Macintosh, Microsoft released it for the PC at the end of 1987. It has the same features of every major spreadsheet package available today. In fact, it has been designed to coexist with the 1-2-3 world; it can read and write .WKS/.WK1 files and can even keep its spreadsheets in that form by default, making transfer of worksheets between Excel and 1-2-3 quick and easy. My exploration of the program has not revealed any missing features, although certain desirable, advanced features of WordPerfect Corporation's PlanPerfect are, regrettably, missing from Microsoft's package.

A DEPARTURE

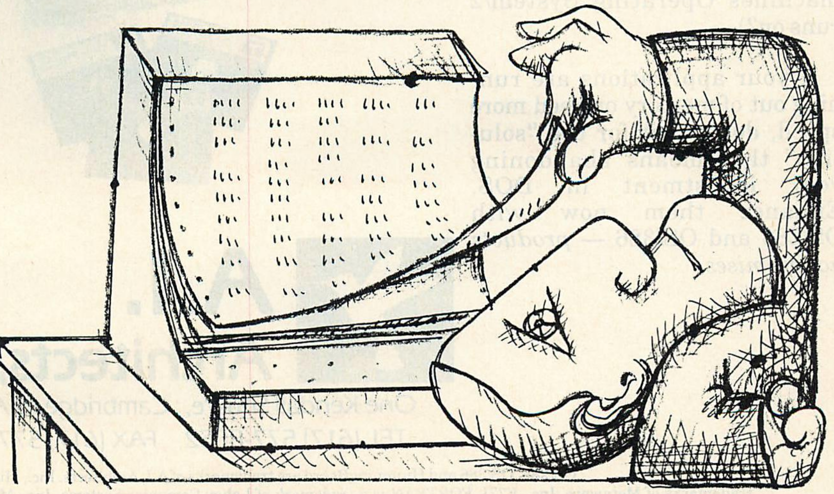
Excel departs from the conventional spreadsheet characteristics, however, and its innovations offer substantial advantages. For example, Excel is very object-oriented; rather than having different ways of formatting cells, columns, or groups of cells or columns, Excel allows the user to specify (by pointing and marking) an object (that is, a cell, block, column, row, group of columns or rows, the whole worksheet) as well as a format to be applied to that object. The act of telling Excel to "format that thing" is the same regardless of the nature of the thing.

Formatting offers another example of how Excel has been extended over other spreadsheet products. Most other spreadsheets have a predefined set of formats from which the user can select; Excel is no different. However, if the provided formats are unsatisfactory (as I have found the limited selection of date formats in 1-2-3), Excel allows the user to define new formats and add them to the list.

This extension to the list of formats becomes a permanent addition that can thereafter be used at will. User-defined formats are the first evidence the casual user will see that Excel can be extended; the Excel Macro Language allows even more complex extensions, including cell formats beyond those that can be specified in the format list.

Excel's object orientation goes beyond cells in the worksheet. An important distinction between Excel and other spreadsheet products is that a graph becomes a type of worksheet (in other words, an object) rather than a procedure that a user must follow. This allows the user to open a worksheet, then open a window for the graph and watch the graphic be updated in realtime as data are modified in the worksheet.

This is the first indication the user will see of dynamic data exchange (DDE), which Microsoft has been talk-



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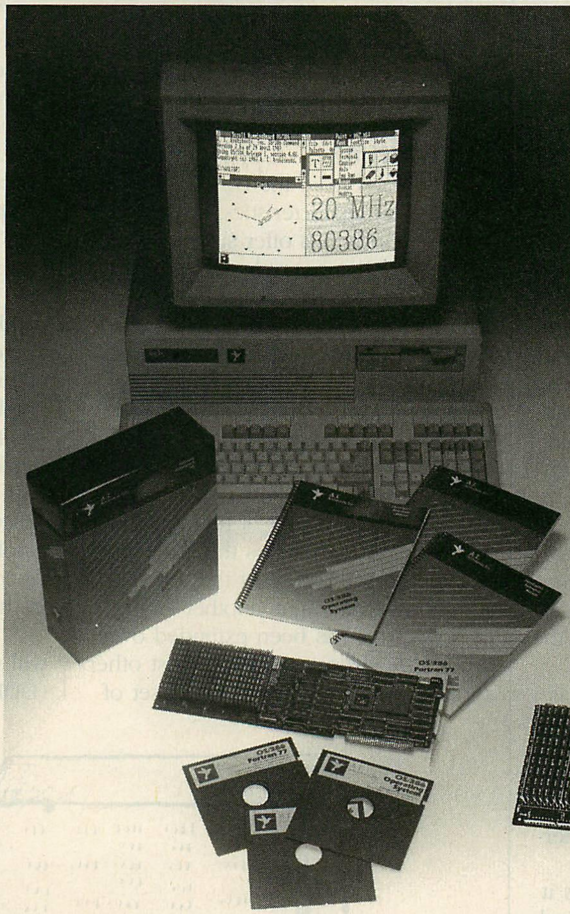

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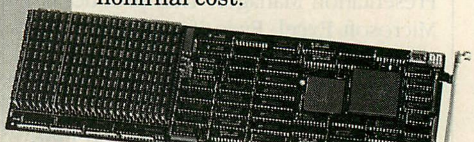

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ing about for some time and which we can expect to pervade Presentation Manager applications.

The connection between a worksheet and its graphs is implicit. Excel follows the MultiPlan and PlanPerfect tradition of allowing the user to define explicit relationships between worksheets. These connections, or *links*, represent the most important, emerging feature of the next generation of spreadsheets (this capability will be present in 1-2-3 Release 3). Links eliminate the need for huge, monolithic spreadsheets, allowing worksheets to be built in compact, logical units that are easier to understand and maintain.

In a budget, for example, the complexities of salaries can be relegated to one worksheet, while the main spreadsheet can link only to the totals. Such an organization also allows a group of people to work on the worksheets in a workspace; sensitive data like salaries can be protected from view without securing the entire set of sheets.

Excel's workspace concept allows the creation of worksheets that contain nothing but records of a certain type; the data functions can be activated from a cell on an independent worksheet, another way monolithic sheets can be avoided and data modularized.

Finally, Excel includes a typical, spreadsheet-style data manager. One useful feature, first seen on PCs in PlanPerfect, is the data-entry form. Excel automatically creates a form and lets the user browse through the data with it as well as enter or modify records. This form is another object of some value when considered from the macro language perspective.

GRAPHICS PREVIEW

We must now ask which characteristics of the Presentation Manager enable Excel features. I have already discussed two: the workspace concept and visual objects. The workspace is enabled because the Presentation Manager environment supports multiple windows. Excel can call upon the Presentation Manager to display a new sheet or graphic on the screen, which the user can visually manipulate into a desired screen position or size. Within the sheets, Presentation Manager features will enable applications like Excel to point (usually with the mouse) and mark (by shading screen regions).

In the future, the workspace concept can be extended to include objects that are driven by multiple applications, not just multiple objects under the control of a single application. This is a significant departure from the current Macintosh technology, which does not (yet) include multitasking. With the addition of an intertask communications facility like DDE, a user could be running multiple programs simultaneously to work on a problem.

Perhaps DDE will spell the end of directly integrated packages; with an appropriately constructed data manager that is able to communicate directly with a spreadsheet like Excel, the spreadsheet would not even need any data management capabilities.

The Presentation Manager's graphics user interface also enables presentation-quality graphics. The hard-copy output quality of Excel is one of its most compelling features, considering how much number-crunching goes into plans and proposals. To belabor the point, the Presentation Manager allows work from multiple applications (such as a data manager, spreadsheet, and graphics package) to be combined easily into one document.

Having an appropriate data interchange facility lets all the information about document formatting be passed along with the data. Eventually, the document processor will not require the user to cut and paste, but will simply need to be told where each piece is and where it goes in the document. The underlying applications will take care of the rest, dynamically.

TIP OF A CONCEPT

What can be done with Excel interactively, though, is just the tip of the iceberg. In addition, Excel sports a macro language that, in itself, is just the tip of a concept that Microsoft has been working on for some time.

The Excel Macro Language is something of a misnomer. From a marketing point of view, Microsoft needs to compete with products that have macro capabilities, so referring to Excel's comprehensive programming facility as a macro language is probably necessary, even if it is a less than apt description. Excel macros do not resemble the typical spreadsheet macro in the least. Even macros created through the record macro facility are stored in a symbolic form in a subordinate spreadsheet and can be examined and modified just like an ordinary program.

The record facility is complete, too; whatever the user can do interactively can be recorded and replayed. This may lead to some complexity for end users, because macros must be

constructed carefully if they are to have the desired result when replayed. For example, is the marking of a block of cells to be relative to the cursor position when the macro began execution, or is the block of cells to be absolute?

Systems professionals, on the other hand, will not be bothered by such complexity; they will find the macro language very complete and will be able to work from scratch to develop powerful functions or procedures for a particular spreadsheet application.

In fact—and this is the important point—developers can build a complete application with Excel's macro language just as they would with a data manager language or a conventional programming language. These applications can even perform such functions as replacing the Excel menu bar with their own menus, thereby completing the conversion of Excel from a general-purpose spreadsheet product to a specific, dedicated user application. The transformation is so complete that the end user might not be aware that Excel has any other capabilities beyond the familiar application.

But wait—there's more. The macro language knows about all the Excel objects, of course, but it also knows about the objects that make up the Windows (and presumably the Presentation Manager) universe. An application written in Excel can do the same jobs that a typical Windows application can do, such as opening a window or displaying and manipulating a dialog box. In effect, Excel is a development environment for Windows.

A COMMON LANGUAGE

Although Excel is not the first product to incorporate a programming facility that knows about its own universe of objects (every data manager's language offers that), and although it is not the first product to know about Windows' objects (Whitewater's Actor does that), it *is* the first product to offer both of these capabilities. It will not be the last. That is what Microsoft's Macro BASIC concept is all about.

Microsoft Chairman Bill Gates has been mulling over this idea for several years. Simply stated, Macro BASIC is the language that Gates would like to see make up the programming facility for at least all of Microsoft's applications products, if not everyone else's. No product is yet associated with it.

For a software developer, the advantages of a common language across a range of products, even strikingly dissimilar ones, is tremendously attractive. More importantly, the ability to write a program in a language understood by different applications enables the developer to produce a highly integrated application that taps the capabilities of underlying applications. Each of those foundation applications (data managers, spreadsheets, communications programs, etc.) would be highly efficient at dealing with its own universe of objects; the common program would allow objects to move around from application to application.

Imagine the incredible richness of applications as a result of such a high level of integration. Take the simple example of a calculator. This common tool is included in many applications, but each vendor has to build its own. It is not surprising that all of the versions are different.

Now consider the Windows calculator. Suppose the environment could be told to execute a calculator and that a specification for data interchange with the calculator existed. Windows (or Presentation Manager) finds either the Windows-supplied calculator or another compliant program, loads it, and the user proceeds with general ledger, order entry, or even simple tasks such as figuring out how long a file transmission will take. If the calculator itself could be programmed using the common language, a particular application could even supply code that extended or modified the basic calculator as required by the application.

The possibilities are endless. I am beginning to doubt that any single application—like a spreadsheet—can make OS/2 and the Presentation Manager compelling. On the other hand, the possibilities for integrating various building-block applications into specialized, custom applications can have that effect; such applications go further toward solving an enterprise's business problems than the attempts we see today with conventional tools.

Excel may not be the ultimate spreadsheet, and Macro BASIC may not be the underlying language. Lotus will have a Presentation Manager version of 1-2-3 in the future and has already announced plans for LEAF (Lotus Extended Applications Facility), Lotus's code name for its own common language for its own applications products. But Excel under Windows has most of these capabilities now, and is thus a good way to take a peek at what the future might hold for America's basic, desktop computer.

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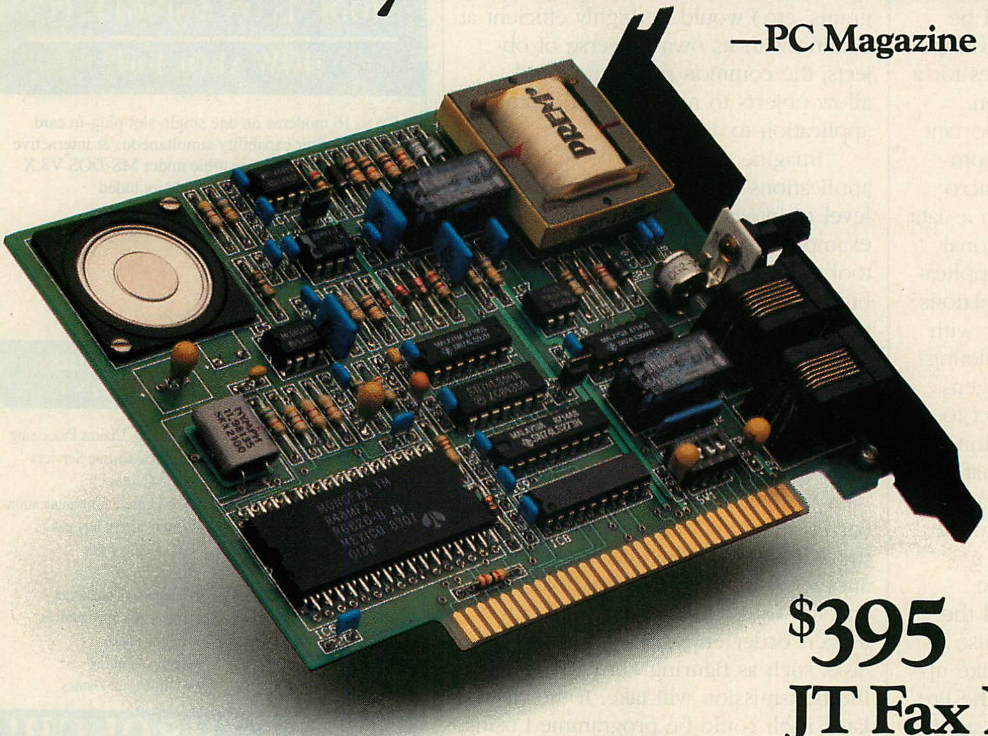

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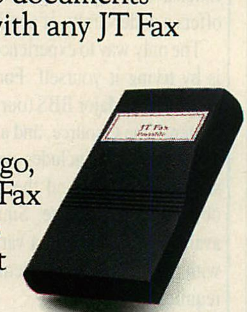

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CIRCLE NO. 172 ON READER SERVICE CARD

RELATED STARS

All this talk about Windows and spreadsheets brings to mind a couple of other products worth mentioning. The first is Borland's Quattro. Quattro is not exactly a 1-2-3 clone, although it can directly read and write .WKS/.WK1 files and execute 1-2-3 macros. Quattro shines in four important areas: price, performance, graphics, and macros.

The price is hard to beat. At $195, and given that many spreadsheets are available mail-order at half list or less, Quattro may be available for less than $100 once the supply catches up with the demand. If Quattro were incompatible with 1-2-3 or somehow represented less functionality, price would not matter. But Quattro is both compatible and offers more.

The performance of the product is quite good. Lotus has been a bit too slow in getting the most contemporary thinking about recalculation integrated into 1-2-3. It is coming with Release 3, but Quattro, Excel, and PlanPerfect are all speedier now. Fast and attractive graphics are built in to Quattro; printing graphics is done from within Quattro rather than by another program. And macros, though not up to the level of the macro language in Excel, are compatible with 1-2-3. Quattro also offers a built-in development facility, including debugger, a major improvement over 1-2-3.

The second product worth a mention is ClickStart from hDC Computer Corporation. This is a menu-based front end for Microsoft Windows. One of Windows' biggest weaknesses is getting an application started. The easiest way is to add extensions to the list in the WIN.INI file, which is the Windows equivalent of AUTOEXEC.BAT. Once that is done, clicking on a file name with that extension starts the specified program. However, WIN.INI has a hair trigger; accidental modification of the file can result in unexpected alterations in the environment.

Microsoft had developed a prototype application called STARTER, which provided a menu similar to that of IBM's TopView, Quarterdeck's DESQview, or Apple. With the STARTER application running, clicking on the icon brought up a list of applications; a second click on the application brought it up. I expected STARTER to show up as one of the desktop applications included with Windows, but it has apparently been shelved. That's okay, because ClickStart is even better. It provides exactly the same functions as the abandoned Microsoft program, but it does them much better. For example, ClickStart's menu structure is hierarchical, allowing a much more complex structure to be built.

The best feature, however, is ClickStart's ability to start a program by first presenting a list of possible files and allowing the user to select the one to be processed. For example, if I am writing letters, I can tell ClickStart to run WordPerfect and show me all the .LTR files first. I can then click on the desired file, which ClickStart will place on the WP command line. In addition, ClickStart cleverly offers the option "none," which then starts the program without a parameter.

A menu program like ClickStart, of course, must be resident at all times to be useful. Thus, it consumes valuable DOS memory. The improvement to the Windows interface is so useful, however, that it is worth the memory; you might find that other applications you have kept resident can be loaded quickly enough with ClickStart that they can be relegated to hard disk.

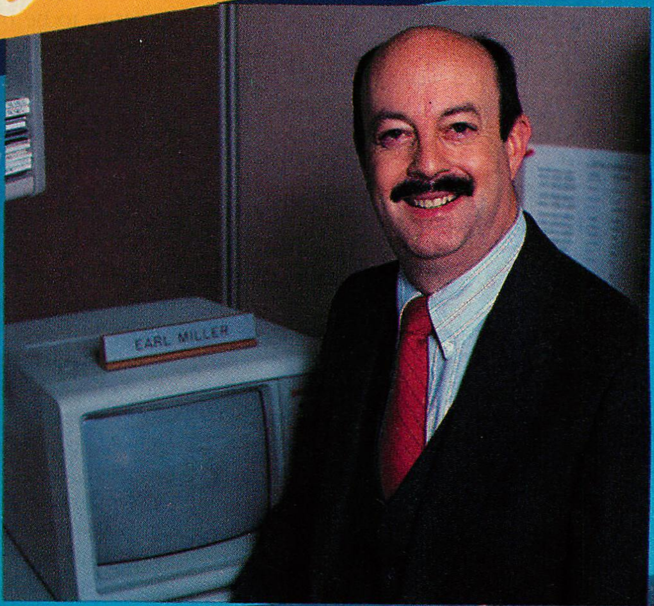
The specification for the OS/2 Presentation Manager is not yet complete, so it is not clear if such a facility will exist in the basic product. Nor would an hDC spokesman speculate on plans for OS/2. I am sure that one way or the other the capability will be present.

20-MHz CLONE

On another front, the first clone of Compaq's 386/20 has appeared: the FlexCache 386 from ALR. It is not precisely a clone, but it does use the Intel 82385 cache controller. ALR claims its performance exceeds the 386/20. Like the Compaq offering, the FlexCache 386 operates at 20 MHz; however, all memory in the machine is zero wait state, which ALR officials say boosts performance. One of the models includes an enhanced small device interface (ESDI) disk controller with 1:1 interleave, and the system unit can accommodate two (as compared to Compaq's single) 300MB hard disks.

ALR is atypical where clone manufacturers are concerned. It does not sell its machines mail order but has a network of dealers. It has concentrated on value-added resellers in the past, but with its current emphasis on high-end machines and its relative speed in introducing new, competitive models, ALR is a company to watch.

Congratulations...



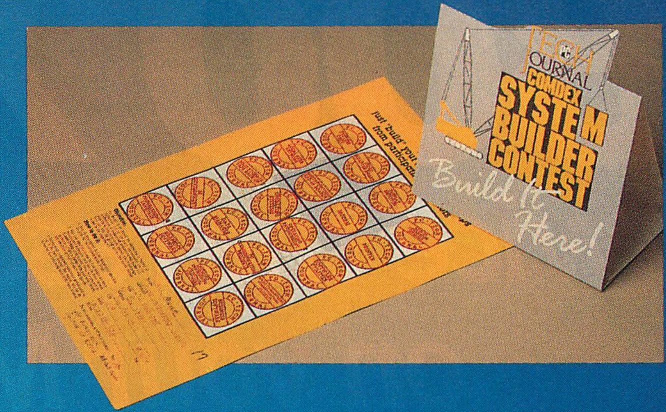
to Earl Miller, a systems consultant at First Interstate Services, a division of First Interstate Bank, Los Angeles, CA. Earl is the winner of *PC Tech Journal's* 1987 System Builder Contest. Those of you who were at Fall COMDEX may remember the System Builder Contest-the one that offered contestants the chance to win the "ultimate PC system" as voted by COMDEX attendees.

Earl Miller represents a typical *PC Tech Journal* reader; a systems professional in a business environment charged with systems development and integration, need assessment, evaluation and recommendation of products—a job made easier thanks to the information contained every month in *PC Tech Journal*.

The System of Choice

After filling in their PC system gamecard by visiting booths and collecting stickers representing 20 component categories, participants voted for the products considered to be the best in a category. The "ultimate PC system," as determined by our contestants, is composed of:

	Reader Service #
• Canon Model BJ-130 BubbleJet Printer	262
• Borland QUATTRO	231
• AST Research Premium 286 system	241
• Princeton Graphics Systems UltraSync monitor	251
• Microsoft C	235
• DATAEASE	261
• Software Link PC MOS	257
• Quarterdeck Office Systems Desqview	256
• Micron Technologies Micron Memory Board	260
• VM Personal Computing RELAY Gold	252
• Rodime Doubleplay	250
• Irwin Magnetic Systems Tape Back-Up	228
• U.S. Robotics Courier HST	249
• ComputerVision Personal Designer System	245
• Plus Development HARDCARD	244
• The Santa Cruz Operation SCO XENIX	255
• WallSoft Systems UI Programmer	242
• Fifth Generation Systems Logical Connection	239
• American Small Business Computers Design CAD	236
• Orchid Technology Turbo VGA	234
• TOPS Network Software	232



Thanks to all of the winning companies for donating their product to our winner, Earl Miller. We look forward to seeing all of the exhibitors at our next System Builder Contest.

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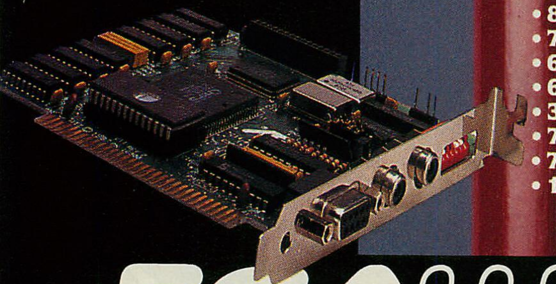

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CIRCLE NO. 171 ON READER SERVICE CARD

TECH RELEASES

The latest in hardware, software, and technology for systems developers and integrators

SP Series from Honeywell Bull

SYSTEMS

A laptop based on the 80286 with processing speeds of 6 MHz and 12 MHz has been announced by **Dauphin Electronics.** The **LP-286** offers four power options (110V, 220V, 12V car lighter, and battery pack). The laptop comes standard with 1MB of RAM (expandable to 4MB); a 3.5-inch, 1.44MB diskette drive; 20MB hard-disk drive with a 65-ms access time; a Hercules-monochrome-compatible, high-resolution (720-by-350 pixel) super-twist backlit LCD screen; two serial ports and

Dauphin's LP-286, an 80286-based laptop

one parallel port; full-sized keyboard; numeric keypad; external modem accessibility; on/off hard-drive switch; and one-year warranty. The LP-286 weighs 15.5 pounds (18 pounds with battery pack). $2,495.
Dauphin Electronics (a division of Dauphin International Trade Center), 1125 E. St. Charles Road, Lombard, IL 60148; 800/782-7922; 312/627-4004
CIRCLE 302 ON READER SERVICE CARD

Two lines of PCs have been introduced by **Honeywell Bull Inc.** The **AP-X Series** and the **SP Series** both incorporate Honeywell Bull's MicroProcessor Exchange (MPX) technology, which comprises a set of 8- and 16-bit expansion slots accommodating an intelligent processor board and an auxiliary support board for input and output functions. These boards both incorporate the use of surface-mount technology (SMT) and application-specific integrated circuits (ASICs).

In the AP-X Series, the MPX technology allows the 8- or 10-MHz 80286 to be upgraded to higher-performance processors, such as the 80386, while retaining IBM PC/AT compatibility. Four standard models of the AP-X can be configured with the buyer's choice of media-storage devices. The basic unit contains a 5.25-inch, 1.2MB diskette drive; the largest standard model includes the same diskette drive plus a 64MB hard disk and 60MB tape backup drive. Up to five half-height storage-device locations are available as well as a wide range of optional peripherals and accessories. Each model has 640KB of RAM (expandable to 8MB). Prices start at $2,950.

Honeywell Bull's SP Series combines its MPX technology with Intel's 80386 microprocessor. The SP Series supports speeds from 4.77 MHz to 16-MHz, which are set by software command. Each unit contains 2MB of 70-nanosecond, interleaved RAM. Three standard models provide a selection of storage-device options, with up to five half-height storage device locations available. The basic model is configured with a 5.25-inch, 1.2MB diskette drive and a 30MB hard disk drive; the largest standard unit includes the 1.2MB diskette drive and a 70MB hard-disk drive with 60MB tape backup drive. Prices start at $5,880.
Honeywell Bull Inc., 200 Smith Street, Waltham, MA 02154; 617/895-6000
CIRCLE 301 ON READER SERVICE CARD

A 20-MHz 80386-based microcomputer has been introduced by **American Computer & Peripheral Inc.** The **American 386-20** computer implements a shadow ROM structure that provides transparent, zero-wait-state BIOS and EGA BIOS operation. The basic 386-20 system includes 1MB, zero-wait-state RAM; a 32-bit expansion slot; five 16-bit slots and three 8-bit slots; a socket to support an 80287 or

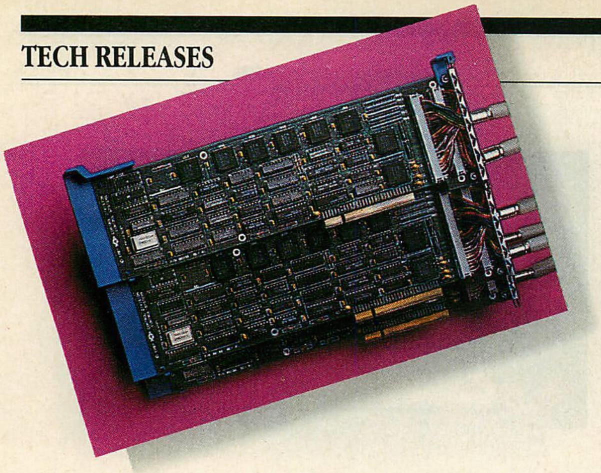
American Computer & Peripheral's American 386-20

80387, and keyboard-selectable clock speeds of 6-, 7-, 10-, or 20-MHz. Contact the company for price information.
American Computer & Peripheral Inc., 2720 Croddy Way, Santa Ana, CA 92704; 800/448-3448; 714/545-2004
CIRCLE 303 ON READER SERVICE CARD

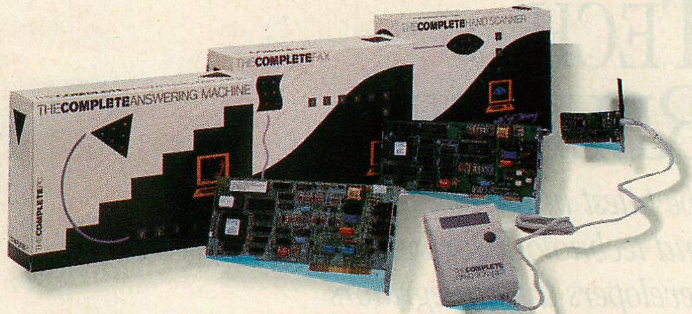
CONNECTIONS

Novell Inc. is now shipping its enhanced LAN operating system, **System Fault-Tolerant (SFT) NetWare 2.1.** This product is bundled with the Btrieve application development tool, which allows developers to standardize data access methods within applications and accelerates the development cycle. Also bundled with the new version is **Message Handling Service (MHS)**, a message transfer and routing service that allows developers to add communications to their applications. Price until April 23, 1988, $3,895.

Novell has also announced its intent to provide NetWare 2.1 users with



HOSTESS/MC multiport board from COMTROL



Voice and data communication products from The Complete PC

compatibility with IBM's OS/2 Standard Edition. **NetWare Support Package for OS/2,** $50.

NetWare Care, network management and diagnostics software for NetWare 2.1 LANs, is also announced by Novell. NetWare Care provides LAN administrators and users with a tool for instantly gauging the performance of file servers, network topologies, and network workstations. The product graphically illustrates the performance and efficiency of various network components on single networks or across bridged groups of networks. NetWare Care Level I for single networks, $495; NetWare Care II for multiple, bridged networks (a maximum of 4 networks), $1,995; each additional network, $395.
Novell Inc., 122 E. 1700 South, Provo, UT 84601; 800/453-1267; 801/379-5900
CIRCLE 305 ON READER SERVICE CARD

Odesta Corporation has announced that **Helix VMX,** its VAX/Macintosh databased networking system, has been extended to include on-line access from VT-type terminals as well as Macintosh workstations. The multiwindowed Helix interface is carried over to the VT terminal automatically. Changes made to the networked database from any terminal or Macintosh are seen instantly on any other terminal or Macintosh on the network. Helix VMX can incorporate information from users of VAXmate and IBM PC applications using Digital Equipment Corporations's VMS Services for MS-DOS. $4,500 to $75,000, depending on CPUs.
Odesta Corporation, 4084 Commercial Avenue, Northbrook, IL 60062; 800/323-5423; 312/498-5615
CIRCLE 310 ON READER SERVICE CARD

A family of data communication products for the IBM PS/2 Micro Channel machines has been introduced by **Comtrol**. The **HOSTESS/MC** is a basic multiport board for adding four to eight serial ports to create a small multiuser system for connecting terminals, printers, and other peripherals. The **HOSTESS 550/MC** adds buffering (no processor) to the basic multiport board to increase performance. The **SMART HOSTESS/MC**, the company's high-end product, has an on-board 80186 and up to 512KB memory. With local memory and direct memory access (DMA), the 186 can process simultaneously with the system CPU and then communicate with it directly; the two processors may interrupt each other. HOSTESS/MC, 4-port, $595; 8-port, $895; SMART HOSTESS/MC, price not yet available; HOSTESS 550/MC, 4-port, $695; 8-port, $1,095.
Comtrol (a division of Control Systems), 2675 Patton Road, P.O. Box 64750, St. Paul, MN 55164; 800/333-1033; 612/631-7800
CIRCLE 308 ON READER SERVICE CARD

Three products are available from **The Complete PC** for enhancing voice and data communication capabilities in microcomputers. **CompleteFAX** is an add-in board that operates in background mode, ready to send and receive FAXs without interrupting PC programs. CompleteFAX supports most dot-matrix and laser printers, ASCII-to-FAX conversion, and CGA, EGA, and Hercules graphics adapters. It also supports Media Cybernetics' Dr. Halo II, Z-Soft's PC Paintbrush, and Microsoft Windows applications, as well as The Complete PC's hand scanner. $495.

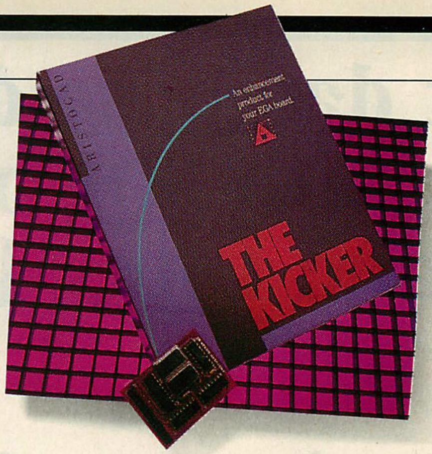
The **Complete Hand Scanner** is a 200-dot-per-inch scanner for text, graphics, and photographs. It includes SoftStationary, a program for merging text and graphics in desktop publishing at PC-based FAX systems. $249.

Also announced are enhancements to the existing personal voice mail system, the **Complete Answering Machine** (CAM), including the ability to share a single telephone line with the CompleteFAX and to put a maximum of four CAM boards and telephone lines in a single PC. The **ProCAM** development package allows OEMs and VARs to develop custom voice-response systems. CAM, $349; ProCAM, $499.
The Complete PC, 521 Cottonwood Drive, Milpitas, CA 95035; 800/634-5558; 408/434-0145
CIRCLE 304 ON READER SERVICE CARD

An enhancement to its Tempus-Access (TA) user-to-data link that allows microcomputer users to extract information from mainframe files has been announced by **Micro Tempus Inc.** The **Tempus-Access/Windows Interface 1.0** (TA/WI) now enables Microsoft Window applications to import data directly from IBM mainframes. Any Microsoft application that fully supports the Direct Data Exchange (DDE) protocol can take advantage of this new feature. Microsoft Excel is the first application to use the TA/WI. Users can specify which mainframe data they want and then import the information directly into their Microsoft Excel spreadsheet without leaving Excel. Prices for TA range from $6,900 to $9,900 for DOS environments, and from $9,500 to $13,900 for MVS environments. TA/WI is available at no charge to TA owners.
Micro Tempus Inc., 440 Dorchester Blvd. W., Suite 1700, Montreal, Quebec, Canada H2Z 1V7; 800/361-4983; 514/397-9512
CIRCLE 306 ON READER SERVICE CARD

An efficient way to connect homogeneous or heterogeneous IEEE 802.3 networks, including StarLAN, Ethernet, and Thin Ethernet, has been unveiled by **Retix**. The **RetixGate Model 2244 IEEE 802.3 MAC Bridge** can be used to interconnect two networks, either directly or through a high-speed backbone network. Two ports are available that can be individually configured by network type. The product's built-in

Attachmate's EXTRA! 1.2 connectivity software with IBM PC



The Kicker, Aristocad's resolution enhancement board

adaptive firmware continuously monitors traffic on the attached networks and builds its own configuration tables. It processes a maximum of 6,000 packets per second while filtering a maximum of 10,000 packets per second. The unit is based on a Motorola 68000 CPU running at 8 MHz. $1,950.
Retix, 2644 30th Street, Santa Monica, CA 90405-3009; 800/255-2333; 213/399-2200
CIRCLE 307 ON READER SERVICE CARD

An enhanced version of its connectivity software, **EXTRA! 1.2**, has been announced by **Attachmate Corporation.** EXTRA! 1.2 is an integrated micro-to-mainframe software package that provides 3270 emulation for coaxial, remote, and LAN connections, including up to four concurrent sessions, windowing, three types of file transfer, 3287 printer emulation, keyboard mapping options, and IBM-compatible application programming interfaces (API). The enhanced version includes support for IBM's APL2 programming language, a background DISOSS (Distributed Office Support System) file transfer, the integration of Attachmate's RemoteStation software, a new setup procedure, and configurable sessions. $425.
Attachmate Corporation, 3241 118th SE, Bellevue, WA 98005; 800/426-6283; 206/644-4010
CIRCLE 309 ON READER SERVICE CARD

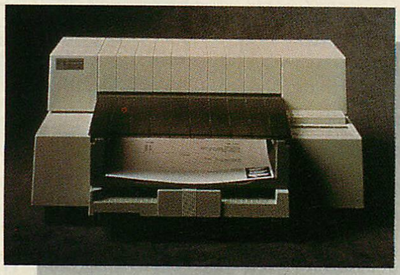
Two X.25 screen emulation programs for IBM PS/2 Models 50, 60, and 80 have been announced by the **TDT Group.** Both emulations use the standard IBM multiprotocol adapter, and both employ the X.25 gate and may be run simultaneously, with a hot key to switch between the two programs (switching to a third DOS session via hot key is also possible).

IBM 3270/3770 terminal emulation offers seven-color emulation for the 3278 and 3279, 3287 printer or virtual printer to disk, APPC programmable interface, support for all 3770 emulation devices, an SNA/SDLC/NPSI interface, minicluster via asynchronous couplers, and six logical units (LUs) per station. $599.

The **Honeywell Bull VIP terminal emulation** provides emulation for the 7700 and 7800 series, TTU printer or virtual printer to disk, file transfer FTF or MICROFIT, CPI8 programmable interface, API programmable interface, and DSA interface. $549.
TDT Group, 444 Brickell Avenue, Suite 902, Miami FL 33131; 305/372-9332
CIRCLE 311 ON READER SERVICE CARD

PERIPHERALS

A low-cost personal printer with laser-quality output has been announced by **Hewlett-Packard Company**. The **HP DeskJet Printer** outputs high-resolution text in multiple fonts and full-page graphics at 300 dots per inch (dpi). It uses all common office paper and also handles merged text and graphics output from numerous application packages. It prints text at speeds of 120 characters per second (cps)—about two pages per minute—for laser-quality text and 240 cps for draft quality. An automatic cut-sheet feeder with a 100-sheet capacity has a front-loading design. The printer features built-in Courier, Courier Bold, and Courier Compressed fonts. Two accessory cartridge ports extend font capability, allow for memory expansion (a maximum of 256KB), and provide for an Epson FX-80 printer emulation cartridge. The printer has a 16KB buffer. Multiple fonts are available in a variety of typefaces, sizes, and styles via 12 font cartridges and as well as one soft or downloadable font with universal character sets. $995.



HP DeskJet Printer from Hewlett Packard

Hewlett-Packard Company, 3000 Hanover Street, Palo Alto, CA 94304; 415/857-1501
CIRCLE 316 ON READER SERVICE CARD

Aristocad Inc. has introduced **The Kicker**, a resolution-enhancement board that allows most EGA cards, when paired with NEC's MultiSync and compatible monitors, to boost their 640-by-350 resolution to 800-by-600 pixels. The Kicker plugs into the features adapter of most EGA cards. The product includes an installation guide and software drivers for popular desktop publishing and computer-aided design (CAD) programs. Driver support includes Microsoft Windows, DRI's GEM Desktop, Xerox's Ventura Publisher, Autodesk's AutoCAD, and Versacad's VersaCAD at 800-by-600 pixel resolution in 4 colors. An added feature for Ventura users creates a 1024-by-800 pixel virtual window. $195.
Aristocad Inc., 333 Cobalt Way, Suite 107, Sunnyvale, CA 94086; 800/338-2629; 800/426-8288
CIRCLE 315 ON READER SERVICE CARD

A 2MB memory adapter for the IBM PS/2 Models 50 and 60 that fully conforms to IBM's implementation of TRAM (IBM's new address page-mapping mechanism) has been announced by **STB Systems, Inc.** The **STB RapidRAM** memory board supports 10-MHz zero-wait-state operation, which increases performance compared to one-wait-state operation. The

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HOOPS by Ithaca Software lets you assign attributes to objects for advanced graphics applications. Include hidden line/surface removal, multiple light source rendering, and more in 3D with animation. Use natural language. Device independent, call from C, Pascal, or FORTRAN. Regularly $549 ($575 retail), **until March 31, 1988 .... only $419.**

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386 Debug - by Phar Lap	PC	$ 129
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DESQview PS/2	PC	$ 109
F77L-EM - by Lahey	MS	Call
High C - by MetaWare	PC	Call
OS/286 & 386 by AI Architects	PC	Call
Paradox 386	MS	$ 799

AI Languages

APT - Active Prolog Tutor - build applications interactively	PC	$ 49
ARITY Prolog - full, 4 Meg Interpreter - debug, C, ASM	PC	$ 229
COMPILER/Interpreter-EXE	PC	$ 569
Cogent Prolog Compiler	MS	$ 179
MicroProlog Prof. Comp./Interp.	MS	$ 609
PC Scheme LISP - by TI	PC	$ 85
Star Sapphire	MS	$ 429
TransLISP - learn fast	MS	$ 79
TransLISP PLUS	MS	$ 149
TURBO PROLOG by Borland	PC	$ 69

Others: IQ LISP ($239), IQC LISP ($269)

Basic

BAS_C - economy	MS	$ 179
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Basic Development Tools	PC	$ 89
db/Lib	MS	$ 119
Exim Toolkit - full	PC	$ 45
Finally - by Komputerwerks	PC	$ 85
Inside Track	PC	$ 49
Mach 2 by MicroHelp	PC	$ 55
NetWorks by Exim	PC	$ 89
QBase - screens	MS	$ 79
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Quick Pak-by Crescent Software	PC	$ 59
Quick-Tools by BC Associates	PC	$ 109
Stay-Res	PC	$ 59
True Basic	PC	$ 79
Turbo BASIC - by Borland	PC	$ 69
Turbo BASIC Database Toolbox	MS	$ 69

FEATURES

SofTRAN, the Translation and Text Language by TransOptima - full procedural language like C plus pattern and nonprocedural constructs cuts development effort by up to 16 times. PC $ 349

FORCE III, Dbase Compiler by Sophco-small .EXEs, user-defined functions, I/O directives through BIOS/DOS/ANSI/FORCE/user-defined, extensions include FOR..NEXT loops, soundex, 1D arrays. Maverick. PC $ 109

RECENT DISCOVERY

CLARION DBMS by Barrington Systems. Fast applications prototyping and development. Language, compiler, screen/report generators, editor, call other languages, read/write dBASE III+ files. PC List:$695

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AZTEC C86 - Commercial	PC	$499
C86 PLUS - by CI	MS	$359
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Instant-C/16M	PC	Call
Lattice C - from Lattice	MS	$259
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Rex - C/86 standalone ROM	MS	$695
Turbo C by Borland	PC	$ 67

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dBx - translator	MS	$299

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C Worthy Interface Library	PC	$249
Curses by Aspen Scientific	PC	$109
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dBASE III LANPack	PC	$649
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dBrief with Brief	PC	Call
dBC III by Lattice	MS	$169
dbug III	MS	$179
Documentor - dFlow superset	MS	$229
Genifer by Bytel-code generator	MS	$279
QuickCode III Plus	MS	$189
R&R Report Writer	MS	$139
Seek-It - Query-by-example	PC	$ 79
Silver Comm Library	MS	$139
Tom Rettig's Library	PC	$ 79
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DataFlex multiuser	PC	$1149
Magic PC	PC	$ 699
Paradox - original	PC	$ 369
Paradox V2.0	PC	$ 469
Revelation by Cosmos	PC	$ 779

Multilanguage Support

BTRIEVE ISAM	MS	$185
BTRIEVE/N-multiuser	MS	$455
GSS Graphics Dev't Toolkit	PC	$375
HALO Development Package	MS	$389
Graphics	PS	$209
Help/Control - on line help	PC	$ 99
HI-SCREEN XL	PC	$129
HOOPS Graphics Library	PC	$549
Informix 4GL-application builder	PC	Call
Informix SQL - ANSI standard	PC	Call
Instant Programmer's Help	MS	$ 79
NET-TOOLS - NET-BIOS	PC	$129
Opt Tech Sort - sort, merge	MS	$ 99
Norton Guides	PC	$ 75
Panel Plus	MS	$395
Pfinish - by Phoenix	MS	$209
Report Option - for Xtrieve	MS	$109
Screen Sculptor	PC	$ 89
SPSS/PC Plus	PC	$749
Synergy - create user interfaces	MS	$329
XQL - SQL for Btrieve	MS	$649
Xtrieve - organize database	MS	$179
ZAP Communications - VT 100	PC	$ 89

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If you ever wanted to take a crack at assembly language, now's the time.

You probably already know that assembly language subroutines are the smartest way to get the fastest programs.

But if the complexities of working in assembler made you think twice, here's some good news. We've made Microsoft® Macro Assembler Version 5.0 a lot easier to use.

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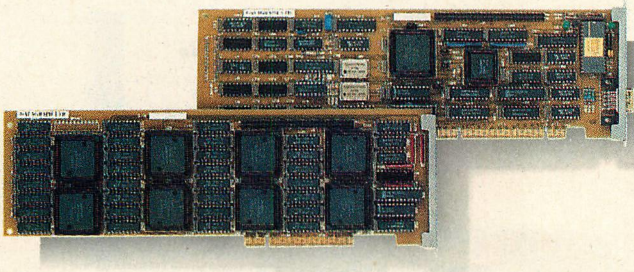


Galaxy Mercury 2 controller from GalaGraph

Qualstar's Ministreamer tape drive next to PC

RapidRam also supports extended memory and LIM EMS 4.0 expanded memory. 0K, $395; 2MB, $995.
STB Systems Inc., 1651 N. Glenville, Suite 210, Richardson TX 75081; 214/234-8750
CIRCLE 317 ON READER SERVICE CARD

A high-resolution, 256-color controller for the IBM PS/2 Models 50, 60, and 80 has been introduced by **GalaGraph Ltd,** whose products are distributed by ElectroGraph Sales. The **Galaxy Mercury/2** offers both 1,024-by-768 and 800-by-600 pixel resolution on the same controller. The controller has 1MB of display memory and is software configurable to either 1,024 by 1,024 by 4 (two pages), or 1024 by 1024 by 8 (one page). The Galaxy Mercury/2 features a 19-inch noninterlaced, flicker-free display format and supports the IBM MCGA and VGA standards. It also follows the GSS VDI and GSS*CGI standards and offers Tektronix 41xx emulation. $2,495.
ElectroGraph Sales, Inc., 1568 Ocean Avenue, Bohemia, NY 11716; 800/327-4304; 516/563-1320
CIRCLE 314 ON READER SERVICE CARD

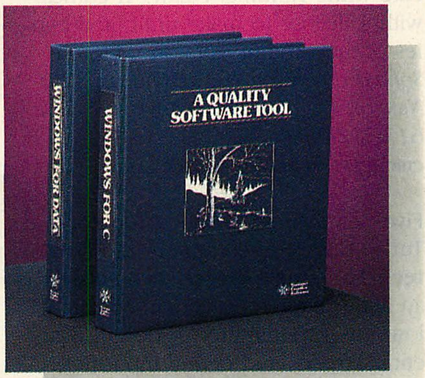
Tape backup systems for the IBM PS/2 Series Models 50, 60, and 80 have been introduced by **Emerald Systems**. The .25-inch tape backup products are designed specifically for the IBM Micro Channel, and for use in either the DOS environment or with Novell's Advanced NetWare 2.x. Ranging in capacity from 60MB to 300MB, the subsystems include Emerald Systems' proprietary tape adapter board to increase performance of the PS/2 products using the existing diskette interface, as well as Emerald's ASP backup software utility that permits complete control over the backup process, unattended backup, diagnostics, and advanced restore facilities. **Models DOS 60-9007** (60MB) and **DOS 150-9007** (150MB) include the tape drive in a self-contained external chassis with the power supply and adapter board that fits in an open slot on the Micro Channel bus. **Model DOS 300-11007** (300MB) uses a larger chassis containing two 150MB tape units. DOS 60-9007, $1,795; DOS 150-9007, $2,695; DOS 300-11007, $5,395.
Emerald Systems, 4757 Morena Blvd., San Diego, CA 92117; 800/553-4030; 619/270-1994
CIRCLE 313 ON READER SERVICE CARD

A compact desktop 6,250-bpi GCR nine-track tape drive has been introduced by **Qualstar Corporation.** The **Model 1260 Ministreamer** can store up to 250MB on a single tape reel and offers fast, secure transfer of data between PC and mainframe/minicomputer environments. The Model 1260 incorporates multiple operating speeds to maintain a constant data rate of 80KB per second, the maximum speed supported by the IBM PC's direct memory access (DMA) channel. A simplified tape path streamlines threading; all tape motion is microprocessor controlled, and the reel servo system is self-calibrating. With standard Pertec interface, $6,975; with 256KB cache buffer, $7,575; with tri-density and 3,200-bpi capability, $7,275; SCSI version with 64KB buffered interface, $7,995.
Qualstar Corporation, 9621 Irondale Avenue, Chatsworth, CA 91311; 818/882-5822
CIRCLE 312 ON READER SERVICE CARD

SOFTWARE APPLICATIONS

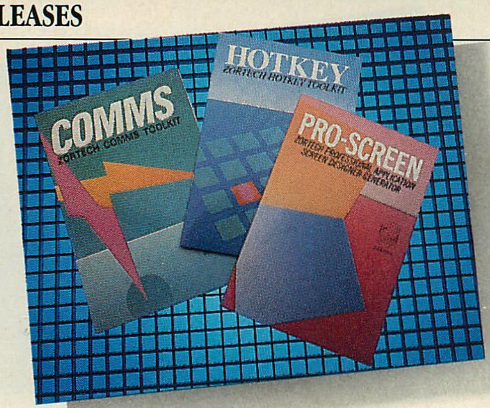
A debugging tool for 80386-based PCs has been announced by **Nu-Mega Technologies. Soft-ICE** uses the 80386 protected mode and surrounds the DOS environment in a virtual machine, allowing realtime breakpoints for memory accesses, memory ranges, program execution, port accesses, and interrupts. Soft-ICE runs entirely in extended memory, giving the target program a full 640KB of memory with no side effects from the debugging code. It works as either a stand-alone tool or as an assistant to other software debuggers, such as Microsoft's CodeView and SYMDEB, enabling the user to work with a familiar interface. $386.
Nu-Mega Technologies, P.O. Box 7607, Nashua, NH 03060-7607; 603/888-2386
CIRCLE 319 ON READER SERVICE CARD

Window-based program development systems for OS/2 development are now available from **Vermont Creative Software** (VCS). OS/2 versions of **Windows for C** and **Windows for Data**

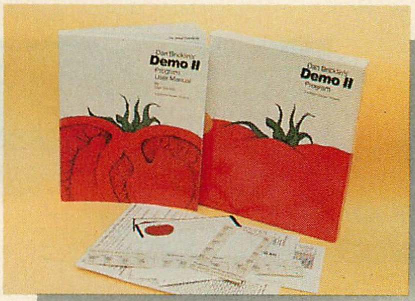


Vermont Creative Software's window-based products

are available for the IBM C/2 compiler and the Lattice OS/2 C compiler. VCS Windows for C is an integrated system of high-level and lower-level C-language functions for creating and managing menus, data-entry forms, context-sensitive help, and text displays—all within windows. It provides portability across operating systems. Features of the OS/2 version of **Windows for Data** includes nested pop-up forms and menus, field entry from a list of choices, scrollable regions for the entry of multiple lines of items, and an ex-



Zortech's Turbo C add-on products



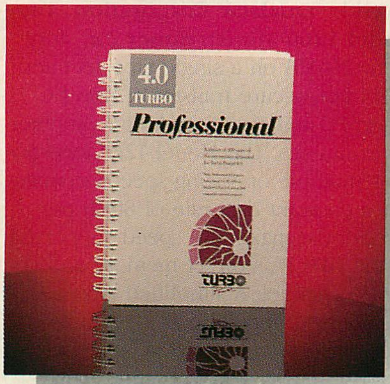
Dan Bricklin's Demo II Program from Software Garden

clusive built-in debugging system. Windows for Data (includes Windows for C) OS/2 version, $495.
Vermont Creative Software, 21 Elm Avenue, Richford, VT 05476; 802/848-7731
CIRCLE 325 ON READER SERVICE CARD

The release of **Dan Bricklin's Demo II Program,** which adds 75 features to the original Demo Program that produces program prototypes, demonstrations, and tutorials, has been announced by the **Software Garden**. Added features include the ability to capture bitmapped graphics images from other programs, string and numeric variables, and a flexible run facility with over 100 new actions to execute while running. DEMO II comes with a license to make unlimited copies of the runtime version. $195.
Software Garden Inc., P.O. Box 373, Newton Highlands, MA 02161; 617/332-2240
CIRCLE 323 ON READER SERVICE CARD

Five new add-on products for Borland's Turbo C have been announced by **Zortech Inc.** The **Zortech Pro-screen** is an application code generator that allows the programmer to design data-entry screens and define input fields and input criteria; the product then generates appropriate source code ready for compiling with Turbo C. The **Zortech COMMS Toolkit,** a serial-communications toolkit for Turbo C, includes support for a maximum of eight serial ports and 19,200 baud rate, file upload/download; terminal emulation; and Xmodem, Kermit, Hayes support. The **Zortech Hotkey** is a set of terminal-and-stay-resident (TSR) functions, together with source code, for creating pop-up programs. **Zortech Windows** allows the programmer to create programs with fast-action windows that zoom onto the screen. The **Zortech Games Toolkit** includes full source code for learning game programming. The manual explains three games of strategy. Each package, $49.95.
Zortech Inc., 361 Massachusetts Avenue, Arlington, MA 02174; 617/646-6703
CIRCLE 320 ON READER SERVICE CARD

A library of over 300 routines for use with Borland International's Turbo Pascal 4.0 compiler has been announced by **TurboPower Software. Turbo Professional 4.0** contains over 30,000 lines of code optimized specifically for Turbo Pascal; it includes pop-up memory-resident routines, BCD arith-



TurboPower's Turbo Professional 4.0

metic, long strings and arrays, menus and fast windowing routines, expanded and extended memory access, and runtime error recovery. Sample programs that illustrate how to use the routines include memory-resident keyboard macro processor, programmer's quick reference chart, programmer's calculator, and an interactive menu maker that writes sources code. $99.
TurboPower Software, 3109 Scotts Valley Drive, Suite 122, Scotts Valley, CA 95066; 408/438-8608
CIRCLE 324 ON READER SERVICE CARD

Graphic Software Systems Inc. (GSS) has begun shipping the **GSS Graphics Development Toolkit for OS/2** (GDT), which enables graphics application programmers to take full advantage of OS/2's multitasking and virtual memory. GSS also announced a GDT-to-driver that will enable unmodified Presentation Manager applications developed with the GDT to run within Presentation Manager Windows. The GSS GDT for OS/2 includes more than 65 high-level functions for bitmap and vector graphics. It has language interfaces to C, FORTRAN, Pascal, and BASIC compilers, as well as macro assembler implementations from IBM and third-party companies. In addition, it supports the IBM PS/2 Mouse; Microsoft Mouse; CGA, EGA, VGA, and 8514/A display adapters; IBM Proprinter II, Graphics Printer, Color Graphics Printer, and Quietwriter III; IBM and Hewlett-Packard plotters; and the HP LaserJet+. The OS/2 GDT is source code compatible with DOS, XENIX and UNIX V implementations. $695.
Graphic Software Systems Inc., 9590 S.W. Gemini Drive, Beaverton, OR 97005; 503/641-2200
CIRCLE 322 ON READER SERVICE CARD

New functions, support for IBM PS/2, PC, XT, and AT computers, and compatibility with Microsoft C 5.0 and QuickC and Borland International's Turbo C compilers are features of **versions 3.2** of **DisplayExpress** and **C-Display Librarian**, announced by **Sydetech Development Technologies, Inc.** DisplayExpress 3.2 can be used to design screens and menus and call them from interactive programs written in C, Pascal, or FORTRAN, and use them for demos and prototyping. Display Express' runtime display processing library provides for easy loading and displaying of screens and pop-up and pull-down menus. $69. The enhanced C-Display Librarian is a library of C functions for developing interactive programs and graphics applications. It performs BIOS calls, screen editing,

PVCS

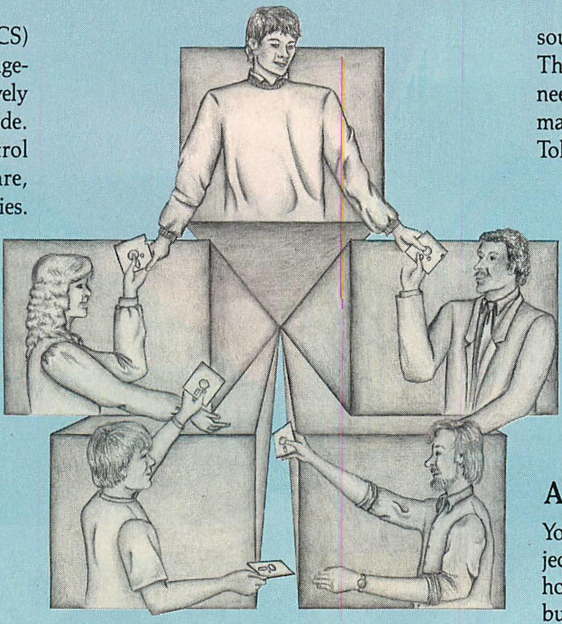
MS-DOS COMMON INTERFACE & FILE FORMAT VAX/VMS

The Number One Source Code Control System.

The POLYTRON Version Control System (PVCS) simplifies and automates Configuration Management so programmers and managers can effectively control the revisions and versions of source code. PVCS is the most widely used change control product and is used by the leading software, aerospace, manufacturing and service companies.

"In terms of features, PVCS provides everything necessary to a large multi-programmer project — more than any other package reviewed. No restrictions are placed in the development environment and all aspects of operation can be customized for specific project needs."

PC Tech Journal
September 1987



Unmatched Flexibility

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Project Control

PVCS maintains individual archieves of all project components in your system — source code modules, data files, documentation and even object code libraries. These "source documents" can be written in any language or multiple languages.

Fast Retrieval of Revisions

PVCS uses "reverse delta storage" which saves disk space and speeds retrieval of versions of any file in the project database. A delta is the set of differences between any revision and the previous revision. PVCS can rapidly recreate complete versions of any file whether it is the most recent revision of a module or the original version of the entire project. Differences are automatically detected and stored.

A Practical Necessity for LANs

While important for single-programmer projects, PVCS is absolutely essential for multiple-programmer projects and LAN-based development efforts. In a LAN environment, source code files are simply too easy to change. Because any change to any file can have major ramifications, coordinating and keeping a record of changes is critical. Project leaders can determine, on a module-by-module basis, which programmers can access or modify source files, libraries, object code and other files. The levels of security can be tailored to meet the needs of nearly every project. PVCS works on all major LANs including 3Com, Novell and the IBM Token Ring Network.

"PVCS has helped us maintain nearly 90 programs and utilities. Without it we would not have the quality of our upcoming release of NetWare."

Jonathan Richey
Manager, NetWare Utilities
Novell

Adopt PVCS on Your Existing Projects

You can obtain the benefits for your current project without disrupting development, regardless of how long your project has been under way. You can build PVCS archives from revisions stored in your present files or simply adopt PVCS from the current date.

PolyMake Reads PVCS Logfile Format

PolyMake, the leading Make utility, understands the structure of PVCS logfiles and is able to correctly determine the date and time of any revision. This prevents unnecessary operations that occur when the date and time of the complete project archive itself is used as with other make utilities.

Once you standardize on PVCS, the archives used to track and monitor changes are interchangeable between any PVCS product.

Personal PVCS — Offers most of the power and flexibility of Corporate PVCS, but excludes the features necessary for multiple-programmer projects.

Corporate PVCS — Offers additional features to maintain source code of very large and complex projects that may involve multiple programmers. Includes multi-level branching to effectively maintain code when programs evolve on multiple paths.

Network PVCS — Extends Corporate PVCS for use on Networks. File locking and security levels can be tailored for each project.

PVCS for VAX systems — Requires VMS. Uses the same interface and archive format as MS-DOS version. Supports branching and offers file locking and other security features for multiple-programmer projects.

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Corporate PVCS	$395			
Network PVCS	$995**	$4,950	$9,500	$10,500+
PolyMake	$149			
Network PolyMake	$447**	$1,250	$2,375	$2,500+

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QNX vs. OS/2 UNIX

QNX: Bend it, shape it, any way you want it.

ARCHITECTURE If the micro world were not so varied, QNX would not be so successful. After all, it is the operating system which enhances or limits the potential capabilities of applications. QNX owes its success (over 30,000 systems sold since 1982) to the tremendous power and flexibility provided by its modular architecture.

Based on message-passing, QNX is radically more innovative than UNIX or OS/2. Written by a small team of dedicated designers, it provides a fully integrated multi-user, multi-tasking, networked operating system in a lean 148K. By comparison, both OS/2 and UNIX, written by many hands, are huge and cumbersome. Both are examples of a monolithic operating system design fashionable over 20 years ago.

MULTI-USER OS/2 is multi-tasking but NOT multi-user. For OS/2, this inherent deficiency is a serious handicap for terminal and remote access. QNX is both multi-tasking AND multi-user, allowing up to 16 terminals and modems to connect to any computer.

INTEGRATED NETWORKING Neither UNIX nor OS/2 can provide integrated networking. With truly distributed processing and resource sharing, QNX makes all resources (processors, disks, printers and modems anywhere on the network) available to any user. Systems may be single computers, or, by simply adding micros without changes to user software, they can grow to large transparent multiprocessor environments. QNX is the mainframe you build micro by micro.

PC's, AT's and PS/2's OS/2 and UNIX severely restrict hardware that can be used: you must replace all your PC's with AT's. In contrast, QNX runs superbly on PC's and literally soars on AT's and PS/2's. You can run your unmodified QNX applications on any mix of machines, either standalone or in a QNX local area network, in real mode on PC's or in protected mode on AT's. Only QNX lets you run multi-user/multitasking with networking on all classes of machines.

REAL TIME QNX real-time performance leaves both OS/2 and UNIX wallowing at the gate. In fact, QNX is in use at thousands of real-time sites, right now.

DOS SUPPORT QNX allows you to run PC-DOS applications as single-user tasks, for both PC's and AT's in real or protected mode. With OS/2, 128K of the DOS memory is consumed to enable this facility. Within QNX protected mode, a full 640K can be used for PC-DOS.

ANY WAY YOU WANT IT QNX has the power and flexibility you need. Call for details and a demo disk.

THE ONLY MULTI-USER, MULTI-TASKING, NETWORKING, REAL-TIME OPERATING SYSTEM FOR THE IBM PC, AT, PS/2, THE HP VECTRA, AND COMPATIBLES.

Multi-User	10 (16) serial terminals per PC (AT).	**C Compiler**	Standard Kernighan and Ritchie.
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Networking	2.5 Megabit token passing. 255 PC's and/or AT's per network. 10,000 tasks per network. Thousands of users per network.		
Real Time	2,800 task switches/sec (AT).	**PC-DOS**	PC-DOS runs as a QNX task.
Message Passing	Fast intertask communication between tasks on any machine.	**Cost**	From US $450. Runtime pricing available.

For further information or a free demonstration diskette, please telephone (613) 591-0931.

Quantum Software Systems Ltd. • Kanata South Business Park • 175 Terrence Matthews Crescent • Kanata, Ontario, Canada • K2M 1W8

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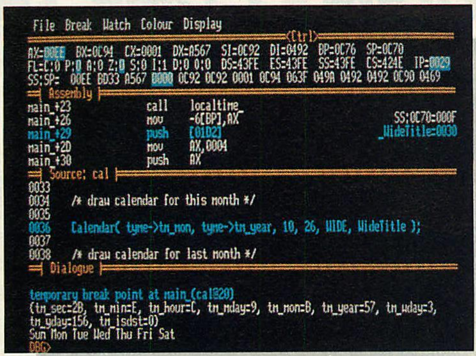
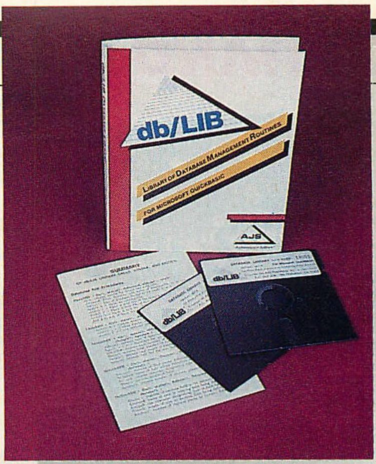


WATCOM's Express C debugger screen



AJS Publishing's database library, db/LIB version 2

data entry and validation. It also provides extended keyboard support and bitmapped graphics. $69.
Sydetech System Development Technologies, Inc., 43-23 Colden Street, #17C, Flushing, NY 11355; 718/886-0221
CIRCLE 321 ON READER SERVICE CARD

Program development environments for PCs using GEM have been introduced by **Prospero Software Inc.** Features of the **Prospero FORTRAN for GEM** compiler include a four-window source editor, a symbolic debugger, an improved linker, and improved compati-

FORTRAN for GEM from Prospero Software

bility extensions in compiler. The FORTRAN compiler is a complete validated ANSI standard FORTRAN-77 level compiler. **Prospero Pascal for GEM**, with the same features as Prospero's ANSI-validated Pascal compiler, is now also available for PCs using GEM. FORTRAN for GEM, $199; Pascal for GEM, $149.
Prospero Software Inc., 100 Commercial St., Suite 306, Portland, ME 04101; 800/327-6730; 207/874-0382
CIRCLE 327 ON READER SERVICE CARD

Two C language products for delivering an ANSI standard C programming environment for the IBM PC and PS/2 DOS systems have been announced by **WATCOM Products Inc.** The **WATCOM C 6.0** optimizing compiler provides tools for producing produce fast, tight code. The code generator permits specification of register and calling conventions to match those of other C compilers and programming languages. The compiler comes with a full range of programming tools, including a windowed source-level debugger. **WATCOM Express C** provides a seamless C development environment that offers error-checking capabilities. It includes an editor, compiler, debugger, and run-time library—all memory resident. Programs may be compiled in memory and then executed directly without separate link and load steps. WATCOM C 6.0, $495; WATCOM Express C, $125; preview prices, $295 and $75, respectively.
WATCOM Products Inc., 415 Phillip Street, Waterloo, Ontario, Canada, N2L 3X2; 519/886-3700
CIRCLE 318 ON READER SERVICE CARD

DATABASE MANAGEMENT

Version 2 of **db/LIB**, a database library fully compatible with Microsoft's QuickBASIC 4.0, has been announced by **AJS Publishing Inc.** The enhanced version provides QuickBASIC with full relational database management capability and read-and-write access to dBASE standard file structures. db/LIB 2.0 features two new libraries in addition to the original db/LIB File Access Library of subroutines which create, manage, and provide full program access to dBASE-type database, index, and memo text files. The db/LIB Data Management Library contains a full set of higher-level routines for record and file management, such as list, browse, or edit. Basic source code is included for each routine in the library and any routine can be modified. The db/LIB Extended Function Library lets application programmers give their users access to many of the data selection and formatting functions of the BASIC or dBASE languages. db/LIB contains a built-in Expression Macro Evaluator, which can parse these user-entered expressions and output the data in the desired format. In addition, db/LIB features its own date arithmetic and date conversion routines. $139.
AJS Publishing Inc., P.O. Box 379, North Hollywood, CA 91603; 800/992-3383; 818/985-3383
CIRCLE 328 ON READER SERVICE CARD

Structured Query Language (SQL) commands and optimized system performance are features of **Microrim's** newest versions of its R:BASE, relational database management system. **R:BASE for DOS** and **R:BASE for OS/2** are major upgrades, totally converted to the C language. R:BASE now supports the Lotus-Intel-Microsoft Expanded Memory Specification (LIM EMS); when memory is available, program overlays are cached into expanded memory, thereby minimizing disk I/O. The new versions include **Developers EXPRESS**, a built-in pseudo-compiler that compresses and encrypts program code, allowing applications to be run directly off the R:BASE engine. R:BASE for DOS also has added multiuser features for sharing data on local area networks. R:BASE for OS/2 has the added benefits of multitasking and increased performance due to the removal of overlays required by a 640KB RAM constraint imposed by DOS. R:BASE for DOS, $725; Network Six Pack, $995; Network Unlimited, $2,695; additional documentation, $100 per set; price for R:BASE for OS/2 is not yet announced.
Microrim, 3925 159th Avenue NE, Redmond, WA 98073-9722; 206/885-2000
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PC BRAND™ SPEAKS YOUR LANGUAGE

CLIPPER *From Nantucket*

Compile dBASE for Speed, Protection

Clipper™ turns lumbering dBASE® into a speed dMON with benefits bobbing in its wake: your source code is submerged from public view, you can distribute your compiled application without royalties, and your customers don't even need copies of dBASE! The Spring '87 Clipper offers index files compatible with dBase III Plus, and networking capabilities to run compiled programs on major networks supporting DOS 3.1 with no restrictions on number of users. Clipper offers arrays, menu-building commands, user-defined functions, context-sensitive help techniques for applications, a debugger, and it supports Expanded Memory. It goes well beyond dBASE with 1,024 fields per data base and 2,048 active memory variables.

Clipper has the power to save and restore multiple screens to and from memory variables. You can also create overlays, call object modules compiled in other languages, and create function libraries to link with your applications. Power and flexibility make it the #1 dBASE compiler. List: **$695**, PC Brand: **$375**.

McMAX *From Nantucket*

Like dBASE for the Macintosh

McMax™ is like running dBASE on the Macintosh. It combines an easy-to-use menu-driven ASSIST mode using the Mac interface, an interactive command mode like dBASE at the dot prompt, and an application programming language fully compatible with dBase III. It gives you the power to create dBASE language applications on the Macintosh and transfer back and forth to the IBM® world. McMax accommodates up to 16 million records, 32,000 characters per record, 255 characters per field, and up to 32 files open concurrently. No copy protection. List: **$295**, PC Brand: **Call**.

dBASE AT THE SPEED OF C

dBx Translates dBASE Applications to C

You dBASE™ programmers know what an expressive and readable language dBASE is. It's a very comfortable development environment. But the price is debased performance. Even compiled dBASE doesn't offer the speed that some users require these days. The kind of speed offered by software written in the C language. The answer is dBx™.

dBx translates dBASE to C. It offers you a major competitive advantage over the next dBASE programmer: Keep writing in dBASE. Take every application all the way to completion. Then use dBx to translate them top to bottom to C!

Other advantages: C is portable, even to other operating systems like UNIX/Xenix™. To the Macintosh or Amiga. dBx gives your applications a passport to places dBASE cannot go.

Has its own file manager for single user, but links to major C file managers—c-tree and dBC—for compatibility with dBASE files or multi-user support. We have everything you'll need, including good advice.

	List:	PC Brand:
dBx	**$ 350**	**$ 299**
with Library Source	**$ 550**	**$ 469**
with Full Source Code	**$1500**	**$1282**

dBC *Identical dBASE III Plus Files Using C*

dBC™ is a series of C libraries from Lattice which creates, accesses and updates files identical to those of dBASE itself. So dBASE can read and update the files too.

What for? It means both C and dBASE applications can operate on the same data bases interchangably. It means C programmers can interface with the big market of dBASE users out there, yet side-step the dBASE language. It means dBASE applications can now be linked to the universe of C libraries and tools to add windows, graphics, statistical analysis, all the things dBASE cannot do. It means the speed and power of C to impress clients accustomed to dBASE!

dBC's functions parallel all dBASE's file handling commands, many decomposed to permit direct data manipulation. Our versions of dBC mimic file formats for dBASE II and III and now dBASE III Plus makes your programs network ready!... as many stations as a network allows. Hands-off mode handles record and file locking and unlocking automatically. Close in functions give you direct lock/unlock control.

Supports all four memory models. dBASE II, III...List: **$250**, Ours: **$195**. dBASE III Plus...List: **$750**, Ours: **$595**. *Pay double and you get source too!*

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C-WORTHY INTERFACE LIBRARY

NEW VERSION!

The C-Worthy™ Interface Library wraps an entire user interface around your application. Its full power can be summoned by only a few high level calls. Sound exaggerated? A single function call can set up a complete text editor in a screen window. Recently acquired by Solution System, over 600 pages of Documentation, Turbo and Quick C version and a complete Interface Library have been added.

- High level calls pop menus and scrollable choice lists to the screen, restoring the background when dismissed.
- Windowing facilities open portholes of up to screen size for viewing virtual screens larger than the physical screen.
- Full context-sensitive help screen management takes over these chores and error messages. Automatic routines interrupt with pageable text windows explaining what to do next.

Novell found it "played a key role and accelerated development" in making its NetWare™ utilities easier for users. Ingenious demo: call for it.

Ask for:	List:	PC Brand:
C-Worthy	**$195**	**Call**
with Forms Library	**$295**	**Call**

THE SPINDRIFT LIBRARY

Fully Functional Fortran Library.

Spindrift's smooth package offers something previously unavailable to the Fortran buffs...a basket of functions, packed to the brim. No more tedious coding. Just call on Spindrift with it's armoury of functions.

Any number of Windows may be defined, each with a striking border and brilliant color. Define "pop-up" screens, Save/Restore images, set Cursor shape. Snare an entire screen into a Character array.

The Keyboard; read it without echo, or sense any keypress during execution. Cursor controlled directly with Edit keys.

DOS interface includes: Call System, Call Exec, Findfrst/Findnext for (*) and (?) file searching. Search the Path, subdirectory and file manipulation, command line argument parsing, date/time functions, DOS environment access, and much more. Other utilities also included.

Specify compiler, Microsoft or Ryan McFarland. List: **$149.00**. Us: **$129.00**

BASTOC *BASIC Into C*

For a trifling price, BASTOC™ moves truckloads of BASIC code over to C. It's a translator which takes in Microsoft Extended BASIC and emits pure K&R C for Microsoft or Lattice. Structures even convoluted BASIC code. Optimized to dramatically reduce execution time. Dynamic string allocation ends BASIC's catatonic halts for garbage collection. Huge worksaver. List: **$495**, Us: **$399**.

BTRIEVE *B-tree File Manager Plus Add Ons*

If networks are on your horizon, betting your future on Btrieve as the one file manager for your C, Pascal, BASIC, and COBOL projects looks like a smart move. Reason? Novell bought Btrieve's creator.

Btrieve's function library takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, space recapture, forward and backward searching. Finds any key in a million in four or less accesses. Files may have up to 24 indexes; fixed record length to 4090 characters; variable length to 64k; indexes up to 255 characters; files of 4 billion bytes.

List: **$245**, Us: **$195**. Network Version List: **$595**, Ours Only: **$465**. Ask about Xtrieve for Btrieve file inquiry, Rtrieve for report writing. For any network that supports the MS-DOS 3.1 file sharing function.

POLYTRON VERSION CONTROL

Source Code Control for Any Language

PVCS allows programmers, project managers, librarians and system administrators to control the proliferation of revisions and versions of source code in software systems. Independent programmers, the leading software publishers and LAN companies, and hundreds of Fortune 1000 companies rely on PVCS to store and retrieve multiple revisions of text. It maintains a complete history of revisions as an "audit trail", generates status reports, and uses intelligent "difference detection" to minimize disk space for each new version.

On Corporate and Network PVCS simultaneous changes to a module are merged into a single new version. If changes conflict, the user is notified. The "Logfiles" used to track changes are interchangeable between any PVCS product.

Corporate PVCS is for multiple programmers. It includes "branching" to maintain code when programs evolve on multiple paths. Personal PVCS offers most of the power and flexibility of corporate PVCS, but excludes multiple programmer features. Network PVCS is the Corporate version for LANs. File locking and security levels can be tailored to each project.

PolyMake Still using a prehistoric Make? Step up to PolyMake, the most popular and powerful Make utility. Most flexible macros of any Make. Now integrated with PVCS and Poly-Librarian for faster performance and precise configuration management.

Ask for:	List	PC Brand:
Personal PVCS	**$149**	**$109**
Corporate PVCS	**$395**	**$309**
Network PVCS	**Call**	**Call**
PolyMake	**$149**	**$109**

PANEL PLUS

Library Source Code Gives It Complete Portability

There are no end of tools for screen design and data entry, but none quite like Panel Plus. Design a screen under program control, use Panel's utility to "run" and test it field by field, then pass it to Panel's code generator which delivers C source code. Options style the code to your compiler's liking, and you can of course do what you like to the source afterward. The code calls Panel Plus's function library, but now *the library comes in source,* so everything produced is highly portable. Not like other screen managers delivered as object libraries and which leave *you* to write the detailed code.

Panel Plus will operate in graphics mode via interfaces to graphics products it supports and can utilize the EGA's 43-line screen. Low-level I/O functions adapt it to various keyboards, screens, operating systems.

Panel's newest incarnation has every imaginable feature. A single screen design can have 1000 fields stacked as visual overlays up to 127 levels deep or as pop-ups. Groups of fields can be moved between levels. Screens can be output as compilable code or stored on disk for loading at run-time. Each field can be boxed, colored, multi-row, word-wrapped, and scrolled horizontally and vertically if larger than its on-screen view aperture. It can be assigned its own help and error message, can be told to accept certain characters, or to match a picture, and to check data after entry—proper dates, number ranges, etc.—using Panel's or your own validation routines. You can add your routines to Panel's test utility because even it comes as source. Fields are accessed in any order and control reverts to your application program after each field for choice of action.

For past Panelists, the new version has smaller and faster field and screen functions, tighter granularity, and an enhanced, reworked library. Major tool for the serious developer. List: **$495**, PC Brand: **$395**.

Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Brand, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.

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PROGRAMMING PRODUCTIVITY TOOLS

BRIEF *Is Anything But. A Whopper of an Editor*

With a name that belies its thoroughness, Brief™ has every feature you've ever contemplated for your editor-in-chief. Text in multiple buffers is scrolled through one or more windows you open, close, resize. A text buffer may be called to different windows to view two areas at once. A change in one changes both. Text blocks may be marked for printing, writing to files, movement to scrap buffers for cut and paste into other buffers, with as many "undo" levels as you want.

Brief has text search abilities rivaling "grep", with wildcards for matching and indifference to intervening characters.

If you use Lattice, C86™, or Wizard, and have 320k, you can compile your C program without ever leaving Brief. It finds the lines with errors, and marches you through the text for repairs.

Parts of Brief were written with its own easy-reading Lisp-like macro language which has structure, conditionals, loops. "Simply the best text editor you can buy", Dvorak *Infoworld*. (Needs 192k.) List: **$195**, PC Brand: **Call.**

C-TREE & R-TREE

B-Tree File Manager Now Has Report Generator

	List:	Ours:	Combined:
c-tree:	**$395**	**$329**	**$541**
r-tree:	**$295**	**$245**	

c-tree: The only major b-tree file manager with network support in the standard low-cost version, c-tree™ gives you record-locking routines for DOS 3.1/3.2, UNIX and XENIX, and it even comes in C source code, yet there are no royalties. Source sticks to K&R, so C-tree is portable. Tests in many environments prove it.

Permits any number of keys for a data file—alpha, numeric, even floating point. Handles files with varied record lengths, multiple keys in one index file. Both high level and decomposed functions. It's the works.

r-tree: Adds the ability to produce ad hoc reports from files maintained by c-tree (v. 4.1 and up). Link a file description to the r-tree™ library, and use any text editor to write report scripts with no further C coding. Reports can access data in several files, select on criteria, join findings into new logical records, sort them, calculate new fields and columns, tabulate by control breaks. Comes in source, same portability as c-tree, and fits any compiler.

WINDOWS for DATA

FIRST PRIZE!

M'Soft Windows Compatible

"Only one package can be easily recommended" said *Computer Language* (June '87) reviewing nine window and data entry products for C. Complete field level functions specify prompt string, field length, data type, screen location, picture, target variable, entry rules, help messages, even functions to call for validation once data keyed in.

Windows for C is a subset. No data entry but all windowing functions. Unlimited windows can be made either to pop up or permanently overwrite the screen, scroll and highlight lists vertically and horizontally. Specify Compiler. Windows for Data: List **$295**, Ours **$259**. Windows for C: List **$195**, Here **$149**.

ESSENTIAL C UTILITY LIBRARY

400 Functions, 30c Each

You've probably seen the speed and power of Essential's C function library without knowing it. Software greats have been using it for some time to give today's top products pizazz and panache.

Now grown to 400 functions Essential produces pop-up menus, saves and restores screens and windows to disk or memory in as little as 1/10th second, and claims the fastest video output available. Library has 50 business graphics functions, 40 string handlers, 28 functions for printers, 18 for mice, 11 for time and date, DOS interface functions for disk error trapping, directory and file creation and management, lots more. Everything in source, including sample programs. We have versions with pre-built libraries for the well-known C compilers, and a source code librarian is supplied for rolling your own.

	List:	PC Brand:
C Utility Library	**$185**	**$119**
Essential Graphics	**$250**	**$183**
Essential Communications	**$185**	**$125**
with Breakout Debugger	**$250**	**$189**

Shopping List for the Power Workbench

	LIST	US
ARITY PRODUCTS		
Arity Combination Package	1095	979
Expert System Development Pkg	295	229
PROLOG Advanced Toolbox	150	119
PROLOG Compiler & Interpreter	650	569
Arity File or Screen Design Toolkits	50	44
SQL Development Package	295	229
Arity PROLOG Interpreter	295	229
Arity Standard Prolog	95	77
AI-EXPERT SYSTEMS		
EXSYS *Development Software by EXSYS*	395	309
EXSYS Runtime System	600	469
Insight 2+ *by Level Five Research*	485	379
AI-LISP LANGUAGE		
IQCLISP *by Integral Quality*	300	Call
IQLISP *by Integral Quality*	270	Call
TransLISP *from Solution Systems*	95	Call
TransLISP PLUS *from Solution Systems*	195	Call
AI-PROLOG LANGUAGE		
APT *Active Prolog Tutor from Solution Sys.*	65	Call
Turbo PROLOG *by Borland Int'l*	100	63
Turbo PROLOG Toolbox *by Borland Int'l*	100	64
ASSEMBLERS & DEBUGGERS		
Advanced Trace-86 *Morgan Debugger*	175	119
C-Sprite Debugger *by Lattice, source level*	175	139
Microsoft Macro Assembler *with Utilities*	150	Call
PASM86 *by Phoenix, Macro Assembler*	195	138
Periscope I Debugger*...The Periscope Co.*	345	289
Periscope II *with NMI Breakout Switch*	175	139
Periscope II-X *software only*	145	105
Periscope III 8 MHz *with Advanced Board*	995	795
Periscope III 10 MHz *Super-fast Version*	1095	875
BASIC LANGUAGE		
Microsoft BASIC Interpreter *for XENIX*	350	Call
Microsoft QuickBASIC *...4.0*	99	Call
BORLAND PRODUCTS		
Reflex & Reflex Workshop	200	129
Reflex *Data Base System*	150	89
Reflex Workshop	70	45
Turbo Basic*...New*	100	64
Turbo C Compiler*...New*	100	64
Turbo Lightning	100	64
Turbo Pascal Developer's Library	395	275
Turbo Pascal 4.0	100	64
Turbo PROLOG Compiler	100	63
Turbo PROLOG Toolbox	100	64
Turbo Tutor	70	49
C COMPILERS		
C86 PLUS *by Computer Innovations...New*	497	397
Lattice C Compiler *from Lattice*	500	299
Let's C Compiler*...w CSD Debugger*	75	54
MWC-86: Mark Williams C Development	495	369
Microsoft C Compiler *...4.0*	450	295
Turbo C Compiler *by Borland...New*	100	64
C INTERPRETERS		
C-Terp *by Gimpel Software*	300	249
Instant C *by Rational Systems*	500	395
Interactive-C *by IMPACC with debugging*	249	219
RUN/C Professional *from Lifeboat*	250	185
COMMUNICATIONS		
Asynch Manager *by Blaise, for C or Pascal*	175	135
Essential Communications *(See Essential Section)*		
Greenleaf Communications *by Greenleaf*	185	139
C UTILITY LIBRARIES		
Blaise C TOOLS PLUS/5.0	129	99
Blaise Turbo C TOOLS	129	99
Blaise C TOOLS PLUS	175	135
C Food Smorgasbord *by Lattice*	150	109

	LIST	US
C Utility Library *by Essential, 300 functions*	185	119
Greenleaf Functions *by Greenleaf Software*	185	139
COBOL LANGUAGE		
RM/COBOL*...see Ryan-McFarland Prod.*		
Microsoft COBOL Compiler	700	Call
Microsoft COBOL Compiler *for XENIX*	995	Call
Micro Focus COBOL*...see Micro Focus Prod.*		
dBASE SUPPORT		
BRIEF/dBRIEF*...Brief for DBASE III*	275	Call
CLIPPER*...from Nantucket*	695	375
McMAX*...dBASE for MAC from Nantucket*	295	219
Foxbase+ *...from Fox Software*	395	Call
Foxbase+ Multi-User	595	Call
APPLICATIONS PLUS*...Fox + Geller*	499	279
QUICKCODE PLUS*...Fox + Geller*	295	170
QUICKREPORT*...Fox + Geller*	295	170
QUICKENTRY*...Fox + Geller*	99	59
The UI Programmer*...Wallsoft*	295	244
The Documentor*...Wallsoft*	295	244
dFlow*...Wallsoft*	149	124
dBx*..dBASE to C Translator by DESKTOP AI*	350	299
with Library Source Code	550	419
with Full Source Code	1500	1099
dBC*...from Lattice...maintains DBASE files*	250	169
with source	500	349
dBC III Plus*...supports multi-user DBASE*	750	499
with source	1500	995
DEVELOPMENT TOOLS		
BASTOC *by JMI, convert BASIC to C*	495	399
BASIC-C *BASIC's functions added to C*	175	139
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It bundles a source debugger and a "make", and sports a "huge" memory model permitting single data objects larger than 64k, but what's really impressive about Microsoft C are the benchmarks reported in Dr. Dobb's. Microsoft runs away from a field of 17 winning 11 of 27 benchmarks.

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Microsoft C has five memory models for code and data, plus non-library support for another thirteen, and boasts alternate math packages for speed versus accuracy, with or without 8087/80287 chips.

Both linker and library manager are part of the package, as is the "make", which knows how to rebuild any size project by compiling only elements which have changed.

It is reportedly used by Lotus, Ashton-Tate and, fittingly, Microsoft itself to develop Windows. Dobb's calls it "the best MS-DOS C development environment value today [for] virtually any kind of program conceivable." 320k suggested.

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Projecting a Graphics Interface

More than just a pretty face for OS/2, the Presentation Manager builds a consistent user interface and supplies device-independent graphics for applications.

ED MCNIERNEY

With OS/2 on the shelves, developers and users can begin to satisfy their hunger for a meaty multitasking operating system. But the Presentation Manager—the sizzle with the steak—is still on the grill, with several months to go before it is ready to be savored by the masses.

When OS/2's Presentation Manager arrives in the fourth quarter of 1988, no one will be able to dispute its lineage. In form, Microsoft Windows 2.0 and the Presentation Manager bear a striking family resemblance. But no matter how similar they are in appearance, the two are barely second cousins in terms of muscle and sinew.

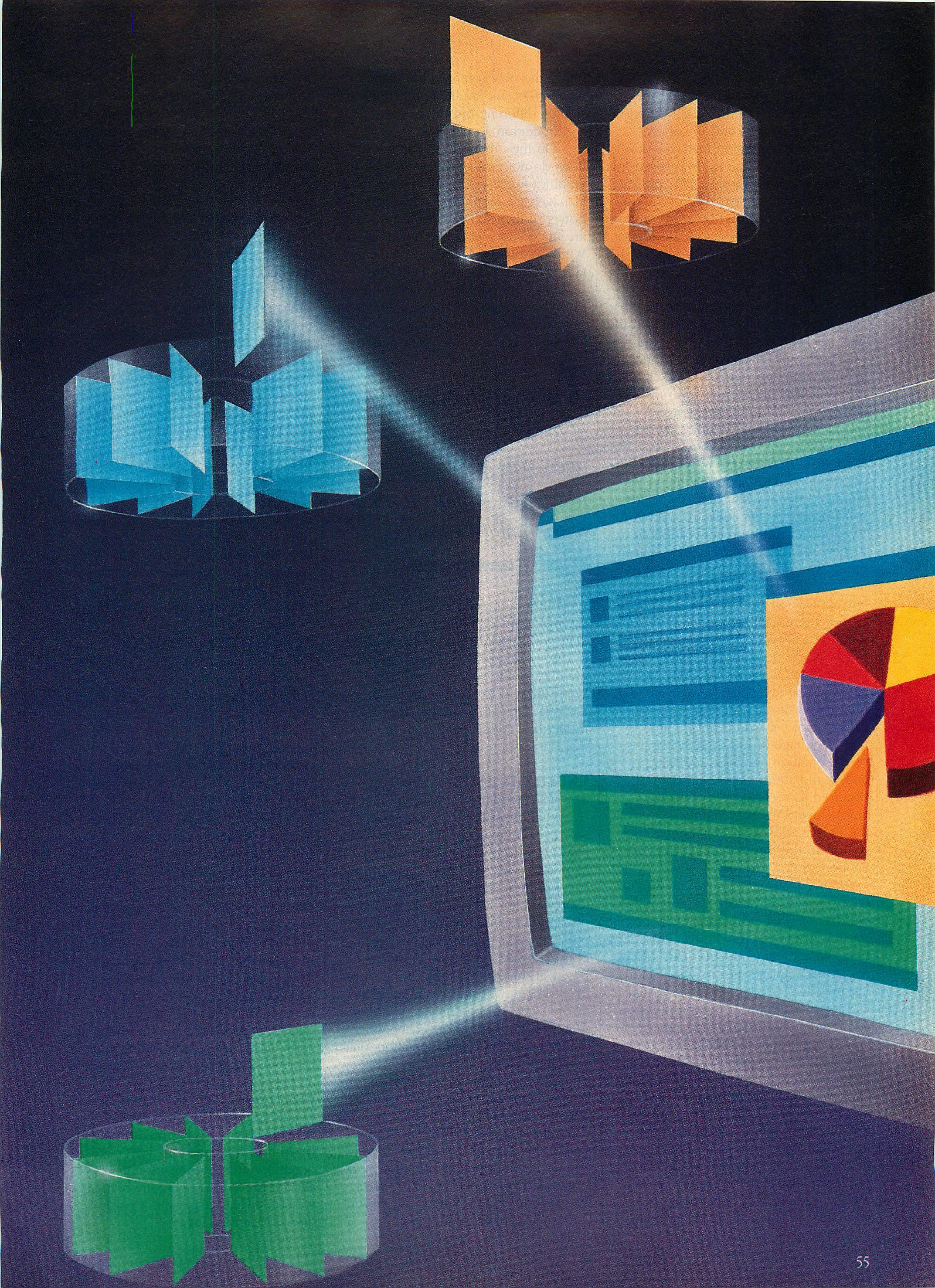
Most of Windows' services have been improved for the Presentation Manager. That was to be expected. Windows and DOS were like two strangers on a blind date—they discovered incompatibilities and their interprocess communication was limited to idle chit-chat. On the other hand, the Presentation Manager and OS/2 are a match ordained in heaven, representing a remarkable fulfillment of OS/2's expandable design.

By providing a set of dynamic link libraries (DLLs) to enhance the functionality of the base operating system, the Presentation Manager builds on OS/2's multitasking capabilities and provides a powerful, flexible graphics user interface. It supports applications software without stepping beyond the bounds of OS/2. DOS has no such multitasking, and Windows, in attempting to provide DOS with the kinds of services the Presentation Manager adds to OS/2, was forced to hook into innumerable operating-system routines. The result was that Windows became one of the most ill-behaved and system-sensitive DOS applications available.

From an applications developer's point of view, the Presentation Manager has a true peer relationship with the applications that use its services. Instead of replacing the operating system, the Presentation Manager simply offers an enhanced applications program interface (API) without hiding or sacrificing any of the underlying services that OS/2 provides to applications that do not use the Presentation Manager. This flexible relationship, coupled with OS/2's multitasking and interprocess-communications features, finally realizes the potential suggested by the Windows environment, creating a rich, graphic, and extensible system.

The Presentation Manager applications interface is a logical extension of the Windows interface, but with a broad degree of generalization and expansion throughout. The interface supports applications development with

ILLUSTRATION • NENEAD JAKESEVIC



essentially the same tools as are needed with Windows, including resource compilers and dialog box editors. The compilers and linkers required for Presentation Manager development are the same as those used for creating character-mode OS/2 applications, because the structure of the application's executable file is the same. In fact, the OS/2 executable file format has grown out of the file format originally designed for Windows.

PC Tech Journal studied a beta test version of the Presentation Manager for this month's cover suite. In the two articles following this one, you will find peeks into the Presentation Manager's user interface (see "The User at the Controls," Ed McNierney, p. 64) and the program interface (see "A Consistent API," Michael Bentley, p. 78).

CONVERTING FROM WINDOWS

Applications developers had been encouraged the last few years by Microsoft's promises that software written for Windows would be readily portable to its new operating systems and environments. Unfortunately, those promises have not come through, and moving any application from Windows to the Presentation Manager will require a great deal of work. In fact, most developers would do well to consider their Windows application's structure before attempting a Presentation Manager port. Although a direct port may be technically feasible, it would not be able to take advantage of the unique features of Presentation Manager applications and would suffer as a result. The time required to reconsider and perhaps restructure a Windows application to fit the Presentation Manager mold could pay off in the form of a superior, better performing product.

Apart from the direct-port issue, developers experienced with Windows will have a great advantage over those starting from scratch with the Presentation Manager. Much of the learning curve for Windows lies in understanding message-based application design and a small amount of interapplication cooperation, and these concepts are readily applicable to the Presentation Manager. The window-management and message-passing features of the Presentation Manager are substantially similar to those in Windows, as are the memory allocation and management routines (see "Windows Memory Management," Guy Quedens and Steven Armbrust, October 1987 p. 66). A software developer who is familiar with Windows will have no problem adjusting to the new routines; the names, parameters, and available functions are slightly different, but the overall feel and operation are familiar.

On the other hand, graphics functions do not fare as well. Although the graphics functions in the Presentation Manager are more complete and more powerful than those in Windows, they are not a superset of the functions in Windows but are based on fundamentally different principles. Reflecting IBM's involvement in the development of both OS/2 and the Presentation Manager, the design of the Presentation Manager's graphics program interface

The most obvious feature of the Presentation Manager—its graphics user interface—is only a small portion of the system.

(GPI) library is influenced strongly by the mainframe Graphical Display Data Manager (GDDM) system. In addition to the Presentation Manager's stored graphics feature (a concept that is brand new to Windows programmers), the very foundation of the graphics model has shifted away from the model that Windows uses.

UNDER THE HOOD

The OS/2 Presentation Manager can be examined most easily by breaking it into its components. The most obvious feature of the Presentation Manager—its graphics user interface—is only a small portion of the system. Actual system operation is based on a number of DLLs that communicate with each other, Presentation Manager applications, and hardware device drivers. By encapsulating the bulk of the system into DLLs, new features can be added or old ones can be enhanced without requiring the code to be changed to the user interface or Presentation Manager applications.

The major libraries comprising the Presentation Manager are the GPI, window management (WIN), and advanced video input/output (VIO). These three systems support user interface and applications development and allow text applications designed for OS/2 character mode to operate under the Presentation Manager window system.

These DLLs can be added easily to the operating system because of an OS/2 facility that allows a parent to provide replacement libraries for its child processes. When the Presentation Manager starts up, it installs replacement libraries for OS/2's VIO, KBD, and MOU calls, overriding the libraries used by standard OS/2 applications for text output, keyboard input, and mouse control. Because the new libraries are in effect for only those applications started under the Presentation Manager, other OS/2 applications are not affected and continue to use the standard libraries' system services.

The Presentation Manager's enhanced libraries not only add services for the graphics interface, but also support all the standard text-based services of the default VIO libraries. Because these services are mapped onto the graphics environment, most OS/2 text-mode applications can run without change in a Presentation Manager window, cooperatively sharing processor time and display space with applications expressly designed for the Presentation Manager environment. In contrast, Windows provides minimal support for what Microsoft calls *old apps*.

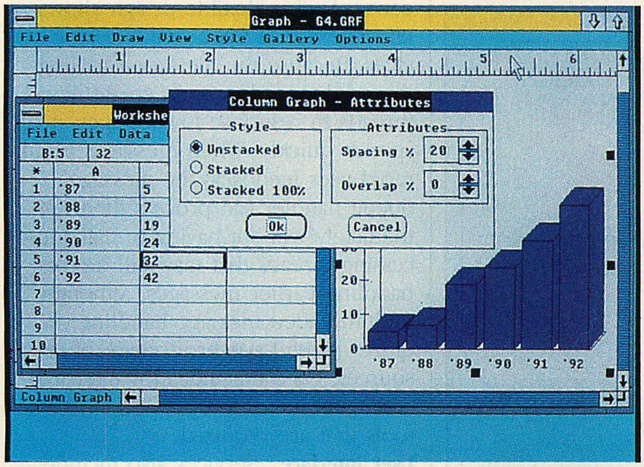
SIMILAR USER INTERFACES

The Presentation Manager's user interface is substantially similar to Microsoft Windows 2.0. Its most noticeable characteristic—and biggest departure from earlier versions of Windows—is its use of overlapping windows that superimpose themselves on the existing screen instead of tiled windows that exist side-by-side on the screen.

The appearance of Presentation Manager windows has not been finished, but Microsoft has indicated that the overall "look and feel" will be essentially the same as that of Windows/386 (see photos 1 and 2). This article summarizes the major characteristics of the user interface; for more details, see the companion article in the cover suite, "The User at the Controls." In addition to application-interface features, the Presentation Manager provides a number of utility programs that allow easier use of the system and a more graphic display of standard operating-system controls.

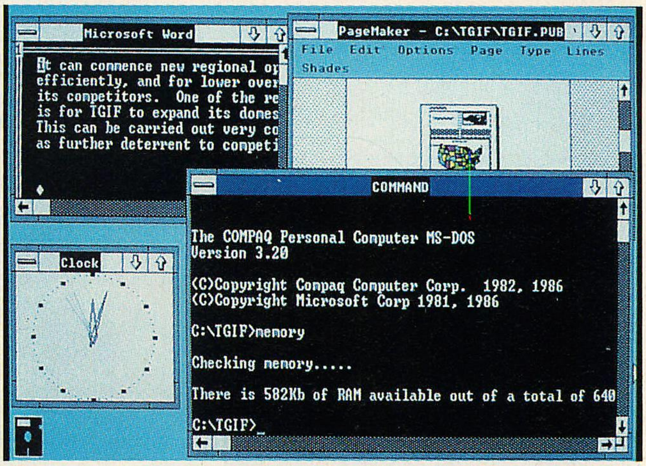
Filing system. The Presentation Manager's filing system is a graphic, tree-structured disk management tool. Similar in function to many of the disk-organizer utilities available for DOS, it allows the user to open any number of windows, each displaying a portion of a disk drive's directory.

PHOTO 1: *PM Graphics Screen*



The ability to mix text and graphics on one screen is carried over from Windows. Switching between windows and interacting with user controls (such as this dialog box with push buttons) are now convenient even without a mouse.

PHOTO 2: *PM Text Screen*



The user can either rotate the stack of overlapping windows by pressing Alt-Esc or bring a particular window to the top by clicking on it with the mouse. Microsoft describes this screen organization as the "messy desk" model.

The menu commands available from the filing system are in the most part similar to those found in the Windows' MS-DOS Executive. Users can view files in different formats, copy, move, and rename files, print text files, organize directory setups, or format and label disks. By opening several directory windows at once, users can select and manipulate multiple files simultaneously and move them from one directory to another. This form of visual file management is similar to the interface provided by the Apple Computer's Macintosh Finder system. The user can start single programs or groups of programs from the filing system by simply double-clicking them with a mouse or by using the File menu's Open command.

Task manager. This utility provides the Presentation Manager with a graphics version of the OS/2 application selector (also called the session manager; see "Enter OS/2," Ted Mirecki, November 1987, p. 52). As programs are started (through any of the several methods available), they are added automatically to the current *switch list*, a list of all running programs available to the user.

Applications running under the Presentation Manager screen group have access to sophisticated start-up facilities that allow them to register descriptive names (rather than file names) on the task-manager display and to modify those names dynamically as the application runs. For example, a word processing program might modify the entry "Word Processor" to "Word Processor (Contract Proposal)" once the user has started working on a contract proposal document. Because several copies of the same program can be running at the same time, better labeling of the switch list allows users to pick the appropriate copy of a program they need.

The switch list also includes applications running in screen groups outside the Presentation Manager, such as standard OS/2 character-mode programs. When the user selects a program from the switch list in the task-manager window, that program becomes the active application and receives keyboard input from the system. If the program is a Presentation Manager program, its main application window is brought to the top and made completely visible to the user; if the program is a character-mode application, the Presentation Manager screen group is moved to the background and the chosen application is made the active and visible screen group. The relationship of Presentation Manager applications to screen groups is illustrated in figure 1.

Although this operation resembles the visual effect produced by switching from Windows to a non-Windows program, Presentation Manager applications and character-mode OS/2 applications are far closer in structure and design than are Windows and non-Windows software—each is designed from the ground up to work in a multitasking environment. As a result, selecting a character-mode application does not cause Presentation Manager applications to stop running. When the user switches back to the Presentation Manager screen group, any applications that were working on time-consuming operations will have made progress in performing those tasks.

Shell help system. The help facility provided with the user-interface shell is another innovation in PC operating software. As IBM tries to generalize its Systems Application Architecture support across the board, a standard help system becomes an important component. Ideally, the user of an OS/2 Presentation Manager application can press F1 (the recommended system help key) at any time and get context-sensitive help for the current operation.

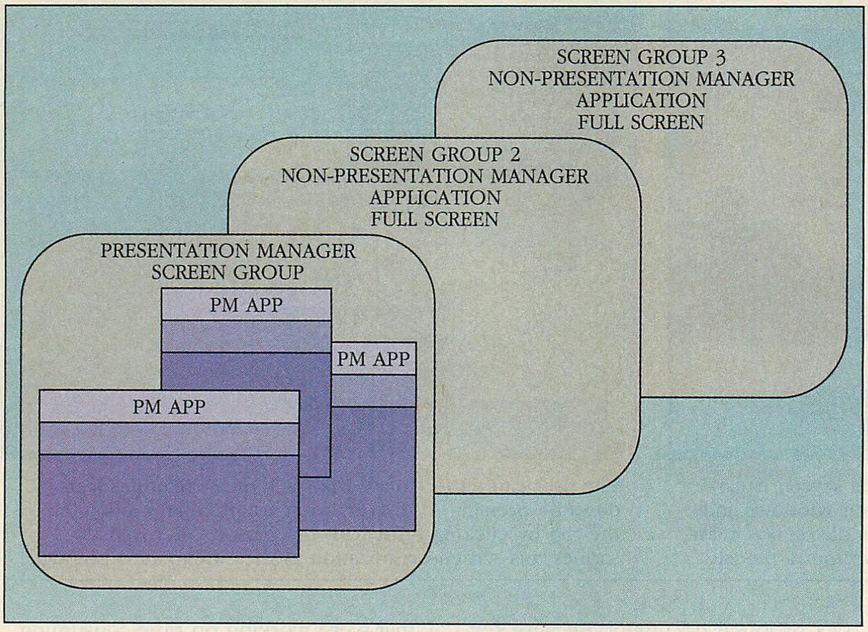
The help supplied by the Presentation Manager for its utilities provides exactly this sort of support; if the user is not performing any particular operation when F1 is pressed, it supplies a general-application help screen with an index. In addition to help within applications, a user program can install two lines of help text as part of its general system registration. This help is available to the user directly from the system interface and allows the user to learn a little about what the application does without actually having to run the application itself.

THE OBJECT OF WINDOWS

The bulk of the Presentation Manager's API functions lies in the window-management library. These functions provide support in three major areas: window management, message management, and the user interface.

The accurate understanding of a Presentation Manager window is crucial to designing an application that takes advantage of the Presentation Manager's

FIGURE 1: ***Screen Groups and Applications***



All Presentation Manager applications share one screen group that can run in parallel with character-mode applications. OS/2 and the Presentation Manager together can facilitate switching among any of the applications in any screen group.

services. As in Microsoft Windows, a *window* is a unit of executable code to which messages can be sent; the window does not have to be associated with a visible rectangle on the display.

Unfortunately, in Windows the term was somewhat confusing because window also referred to the more familiar display entities that applications created. The Presentation Manager attempts to clarify the nomenclature: the term *object window* refers to a window that does not appear in the normal hierarchy of windows that are created by programs and therefore is not visible on the screen. An object window can receive and send messages and perform internal processing, but it is not associated with a visible portion of the display screen.

Each window created belongs to an application-selected window class, and all messages sent to windows of a particular class are handled by the same window procedure. Applications can use the same window subclassing facilities provided in Windows to direct the sending of messages and their handling by window procedures.

Window management. The WIN library provides services to create, display, hide, destroy, enumerate, and move windows on the application desktop, but does not provide explicit services for drawing inside a window. Each window created in a Presentation Manager session has a window handle that serves as a unique address for that window so that messages can be sent to it. Windows are organized in a parent-child hierarchy or tree; the entire screen at the top of the tree—called the *desktop window*—belongs to the Presentation Manager.

Developers who have worked with Windows will be on familiar ground here. Except for adding a few services to make window management easier to use, the Presentation Manager's window-management functions are essentially the same as those in Windows.

Message management. Message handling and processing lie at the heart of the Presentation Manager's design. All application input, whether it comes from the keyboard, the mouse, the system timer, or other applications, is received in the form of messages in an input queue. Many of Windows' message features are carried through in the Presentation Manager, but enhancements have been added to support the Presentation Manager's true preemptive multitasking. Under the Presentation Manager, *threads*, which are used for independently executing functions within an application, must explicitly create message queues to which their messages can be sent; they can specify the queue size required at creation.

Because a Presentation Manager application can be multithreaded, an application can choose to have one thread create a message queue and then create new threads as necessary to process the messages the queue receives. Such a flexible design allows effective use of OS/2's multitasking services. Because the message-handling thread does little except create new threads in response to messages, it responds quickly. When messages require rapid user feedback, the message-queue handler can process them immediately without having to halt processing threads that may still be busy handling earlier messages. Although multithreaded message handling requires careful synchronization of resources, OS/2's facilities for interprocess communication provide all the tools that are required.

User interface. Services also include functions that allow a Presentation Manager application to interact with the user shell, the graphics equivalent of the OS/2 Session Manager. A Presentation Manager application can add or delete itself from the list of available applications, modify which applications are listed, or activate another application by selecting it from the list. Both Presentation Manager and character-mode applications can be entered onto the list and selected.

The user-shell interface services also can retrieve information from the Presentation Manager initialization file, PRESSERV.INI. This file, equivalent to the Windows WIN.INI file, contains modifiable initialization information for both the Presentation Manager and applications developed under it. However, unlike WIN.INI, the PRESSERV.INI file is not an ASCII text file—its contents can be manipulated only through the user-shell API. This change is intended as a user security measure. If PRESSERV.INI can be changed only under the control of Presentation Manager applications (such as the control panel), the chances are reduced of the file being corrupted or inconsistent.

HIGH-POWERED GRAPHICS

The Presentation Manager applications interface differs most noticeably from Windows in its set of graphics services. The Presentation Manager not only offers the graphics capabilities of Windows in its GPI library, but also adds features of mainframe graphics systems to produce a rich and powerful graphics environment. Applications that are written for the Presentation Manager have a large set of graphics primitives, device-independent services more useful than those in Windows, and finer control over the selection and operation of those services.

Drawing modes. Windows provides a draw-as-you-go graphics model in which graphics function calls are translated immediately into visible output on the screen or printed page. The Presentation Manager enhances this simple model with two additional drawing modes, *stored* and *draw-and-store*. Stored graphics are not executed immediately but are placed in a buffer known as a *graphics segment* from which they can be drawn later. Draw-and-store graphics are stored in segments, but they are also executed at the same time.

Windows requires all application drawing to be performed on a *device context*, a representation of the current attribute and output state of a device. The Presentation Manager, however, abstracts the output device one level deeper through the use of *presentation spaces* above device contexts. The device context represents the current physical state of the output device and its device driver; the presentation space defines an application's view of a given device context. Drawing modes, colors, and coordinate transforms are all considered to be attributes of a presentation space.

To perform drawing operations, an application first must create a device context and one or more presentation spaces. A presentation space then must be associated with a device context before any drawing can be performed. Multiple transformations, modes, and attribute sets can be maintained by creating several presentation spaces and associating them all with the same device context.

Once an application is satisfied with the results of a set of calls to the drawing function, it can reassociate the presentation space on which those functions operated with a new device context on a different device (such as a printer or plotter) and repeat the function calls. This capability, when combined with stored or draw-and-store graphics, allows for easy implementation of WYSIWYG (what-you-see-is-what-you-get) applications within the resolution and performance limits of the installed devices.

Another important benefit of stored graphics is that the Presentation Manager system can take care of redrawing obscured or damaged areas of an application's windows that are partially covered by other windows. Instead of asking each application to regenerate the window's contents, the Presentation Manager handles the repainting from the stored graphics data.

Attribute functions. The Presentation Manager's drawing primitives operate with a set of graphics attributes that are greatly enhanced over those offered by Windows. These attributes include sophisticated color selection and color-table layout that allow very fine control over the physical rendering of drawing colors; line patterns, both standard and user-defined; line widths in both non-scalable and scalable units; and line join and end types that allow the application to use round, mitered, or beveled line and arc intersections.

Drawing functions. The drawing primitives provide the capability to draw lines, including curved areas. These functions are based strictly on the current-point/current-attribute concept, in which an imaginary pen performs all drawing. The pen's position moves with each call, using a previously defined set of attributes. This is the most significant change from the drawing method used in Windows. Apart from that change, the Presentation Manager's drawing functions are a superset of those in Windows, with the major enhancements in the support of complex arcs and curves such as polyline fillets and Bezier curves.

In order to perform drawing operations, an application first must create a device context and one or more presentation spaces.

Areas of arbitrary complexity can be constructed by drawing their outlines with a series of line and arc primitives delimited by calls to the GpiBeginArea and GpiEndArea functions. The latter also fills the area with the current fill pattern, and optionally draws the outline in the currently defined line style. Character drawing support also is enhanced over Windows, and includes control over character shear (angle of the character relative to the text baseline), as well as baseline angle control and a full set of attributes and font selections.

The GPI library includes a comprehensive set of digital-differential analyzer (DDA) functions that correspond to line, arc, and spline drawing primitives. These particular functions cause the Presentation Manager graphics engine to generate and store—without actually drawing them—the coordinates of the points on a given line or curve. The application then can use this resulting array to determine precisely which pixels on the display would have been modified by a given primitive. One possible use for the DDA functions might be to place text along a Bezier curve. By finding the points that lie on the curve, the application can align each character properly with the curve.

Clipping and hit detection. The GPI functions for clipping and hit detection provide a very flexible application model. A *clipping region* is an area that contains graphics output; outside it, graphics primitives do not produce visible output. In the Presentation Manager, clipping regions can be arbitrarily complex, even self-intersecting. A clipping region is defined in the same way as a filled area—by drawing its outline with a series of drawing primitives delimited by calls to GpiBeginClipArea and GpiEndClipArea.

Hit detection, the process of determining where a given point lies in a particular drawing, is valuable for interactive applications in which a mouse clicks a portion of the screen display. Because an application can be heavily handicapped by keeping track of all the figures it has drawn and their relative position on the screen, the Presentation Manager allows an application to store its drawings in one or more graphics segments and then play back those segments (without actually drawing them) to determine which primitives intersect with a given rectangular area (usually a small rectangle surrounding the position of the mouse).

ADVANCED VIO LIBRARY

The Presentation Manager supports an alphanumeric presentation space that behaves exactly as a standard presentation space but supports only monospaced text output on a cell-aligned grid. This presentation space can be associated with a device context to provide Presentation Manager applications with a standard method of supporting text-based output.

The advanced VIO library includes support for the bulk of the standard VIO library functions OS/2 supplies, so that non-Presentation Manager applications will typically run in Presentation Manager windows without modification. Advanced features include rich support for multiple character-set loading (up to four character sets at a time) and a variety of cell sizes. Although the de-

fault advanced VIO window supplies an 80-column-by-25 row text display, smaller or larger cell sizes are supported if suitable fonts are available.

As in the rest of OS/2, the Presentation Manager provides comprehensive support for multiple language output and a variety of conventions for representing dates, numbers, and currency symbols. The Presentation Manager supports both code-page switching and multiple-font loading in advanced VIO, keyboard input, and GPI graphics text-output functions. Standard versions of the Presentation Manager shipped to foreign countries will have built-in font support for local languages.

A PREEMPTIVE SYSTEM

Whereas Windows attempted to graft a multitasking environment onto an operating system not designed for it, the Presentation Manager takes advantage of OS/2's inherent capabilities. As a result, the basic multitasking discipline has been changed from the cooperative multitasking of Windows to a truly preemptive system in the Presentation Manager. On one hand, a Windows application could lose control of the processor, but only at clearly defined points and usually by some explicit action on its own part—the application always knew when it lost CPU time. On the other hand, Presentation Manager applications can be interrupted asynchronously at any point and must be designed with that in mind.

A more significant application design change is the ability to support multiple threads in a single Presentation Manager application. While this system allows for very powerful application design, it also adds a layer of complexity to Presentation Manager software. For example, a spreadsheet program might create a new thread to recalculate cells whenever it receives a message that some cell data have changed. While that thread is executing, the user still has control of the application and can move to other cells and edit them. If the user changes a cell's contents from a formula to a value, the recalculation thread should be informed of the change. Or if the user saves the spreadsheet and exits the program, it might not be necessary to finish the recalculation—it can be left until the next time that spreadsheet file is loaded.

Fortunately, OS/2's excellent communications system allows for inter- and intraprocess signaling, semaphores, queues, and pipes. Combined with the shared memory facilities of OS/2, these elements allow Presentation Manager applications to be designed as highly modular, independent components that transfer data among each other through system services and Presentation Manager messages.

BENEATH THE SURFACE

Although most Presentation Manager users will never need to be aware of the design and structure of its interfaces to display and printer devices, they will, nevertheless, directly benefit from an interface that has evolved from Windows into a more powerful, flexible system (see "Windows Virtual Machine," Guy Quedens, October 1987, p. 90). Presentation Manager device drivers provide the system with connections to the actual hardware in use, including the communications devices, displays, printers, mice, and keyboards. Of these drivers, the display and printer drivers are by far the most complex because of their need to support the highly graphic output the Presentation Manager provides on those types of devices.

At initialization, the Presentation Manager establishes a standard set of entry points that implement the GPI graphics routines.

Device drivers under the Presentation Manager are, in a very real sense, another set of automatically started applications that communicate only with the Presentation Manager kernel libraries. They take relatively low-level function calls (for example, draw a scan line, set a pixel, read a color table) into the appropriate hardware commands for the device in use. Because the application interface for graphics (the GPI function library) is high level, it is the GPI library's responsibility to take complex procedures (for example, draw the outline of an ellipse with a wide line) and decompose them into low-level primitives suitable for the device driver.

This hardware interface is structurally similar to the one in Windows, but the Windows interface has several design problems that have been addressed in the Presentation Manager. For example, Windows was designed before the popularity of graphics coprocessors to accelerate the performance of display and printer adapters. Therefore, Windows has not been easy to implement effectively on such devices. Because the interface to the driver is at a low level, devices capable of performing complex operations have some trouble convincing Windows to let them do so.

At initialization, the Presentation Manager establishes a standard set of entry points that implement the GPI graphics routines. These entry points rely upon a small number of required low-level entries that the device driver must supply. These entries are basically the same as those required under Windows. This initialization takes place before the device driver's enable (that is, start-up) entry point is called the first time. A pointer to this table of standard entry points is passed to the enable routine, and the device driver is allowed to modify any of the entry points to point to one of its private device routines rather than to the standard simulation routine. The device driver also can retain the original pointer internally and call back to it if the driver finds a particular device call too complex to handle.

This system allows more powerful or capable graphics displays and printers to pass high-level calls directly to their internal hardware or coprocessors and achieve the best possible performance. Yet, it poses no penalty to the low-capability device, which can simply accept the table as it stands. The callback mechanism aids this process even more. For example, a graphics display adapter might be able to draw ellipses in hardware at very high speeds, but only if they have solid rather than patterned lines. This device driver can steal the original ellipse-drawing routine from the GPI simulation engine and get first shot at any ellipse request. If the request requires a solid line, it will perform the drawing itself; otherwise it will simply hand it back to the GPI code. The GPI code will perform its usual task (most likely generating a series of low-level pixel operations) and pass those requests back to the driver. The result for the user is that drawing takes place as quickly as possible and takes maximum advantage of the hardware available.

Another difficulty with the Windows driver interface was that device drivers (both printer and display) had to be able to draw on bit maps in system memory. Because this operation requires the same code at all times,

redundant software was needed in each driver. The Presentation Manager offers a more cooperative, peer-level relationship between itself and device drivers. The result is a better, more generalized system that needs only the display driver for system memory drawing. Therefore, all other drivers can simply pass their requests on to the display driver for execution.

MORE TOOLS, MORE WORK

Writing Presentation Manager applications requires a considerable amount of start-up work because of the completeness and richness of the execution environment available, but that initial effort is rewarded by the ability to use an unparalleled set of development tools to create sophisticated graphics applications.

As mentioned previously, programmers familiar with Windows will have some advantage, but even they will need to learn the new graphics model of the Presentation Manager.

Windows graphics are based on a pen-and-brush model in which all figures have an interior and a border. The current pen (which has a color, width, and pattern) is used to draw the border of the figure, and the current brush (with its own colors and pattern) is used to fill the interior of the figure. If the application wishes to draw only the outline or only the border, it selects a null pen or brush, as appropriate; the null object has no effect on the drawing destination.

The Presentation Manager replaces many of these concepts with a *current point* using an imaginary pen that performs much like a plotter pen. In order to draw, the application must first set the current point at the start of the figure (that is, pick up the pen and move it), and then execute the drawing (drop the pen and move it).

As an example, examine the functions available for filling and outlining a simple rectangle. Under Windows, almost all graphics functions took a complete coordinate description as part of their parameter set; a call to the Rectangle( ) function required two coordinate pairs, the upper left and the lower right corners of the rectangle. The brush and pen (selected through previous function calls) would be used to draw the rectangle with square corners. If rounded corners were desired, the related function RoundRect( ) would be used. As a result, a Windows code fragment to draw a solid-white-filled rectangle with a black border would look something like

```
SelectObject
  (hDC, GetStockObject
  (WHITE_BRUSH));
SelectObject
  (hDC, GetStockObject
  (BLACK_PEN));
Rectangle
  (hDC, x0, y0, x1, y1);
```

The equivalent operation under Presentation Manager is executed by the GpiBox( ) routine. GpiBox( ) starts drawing at the current drawing point, which must have been set previously by another drawing operation or by the GpiMove( ) function. Rather than using

> *Both applications developers and users will benefit from the enhancements that the Presentation Manager brings to OS/2.*

separate pens and brushes, the application must set the area-drawing and line-drawing color modes, move to the start point, and draw the rectangle while explicitly specifying whether or not to draw either the interior or the border. Rounded corner rectangles are drawn with the same primitive; therefore, the corner styling must be added as well. The resulting code to draw the same rectangle might be:

```
LINEBUNDLE   bLine;
PATTERNBUNDL  bPattern;
bLine.color = 0;
GpiSetAttrs
  (hgpi, BATTR_LINE,
  LBB_COLOR, 0, &bLine);
bPattern.color = 7;
GpiSetAttrs
  (hgpi, BATTR_PATTERN,
  PBB_COLOR, 0, &bPattern);
GpiMove (hgpi, x0, y0);
GpiBox (hgpi, 3, x1, y1, 0, 0);
```

Color 0 is background (black on displays and white on printers) and Color 7 is foreground. The GpiBox parameter 3 causes both the interior and border to be drawn, and the last two GpiBox parameters define the rounding on the corners of the box.

Current-point drawing is close to being a religious issue among graphics programmers, but many believe it is an archaic design and not as well suited to most applications as the specify-everything-in-every-function-call method. It complicates documentation and learning because each primitive needs to explain what it does to the current point; the GpiBox( ) function does not change the current point's location, but GpiLine( ) does. If the next drawing operation does not start where the last one left off, another function call is required. In a Presentation Manager or any other OS/2 environment, it is almost always more efficient to make one function call with more parameters than to make several calls with fewer parameters.

However, forming a judgment on the basis of the code size or efficiency of this or any other single example would be a mistake because, in some cases, the Presentation Manager code will be smaller and faster than Windows. The entire approach to designing graphics applications must be different, and developers who have learned to get the most out of Windows graphics will discover that their work is not portable to the Presentation Manager.

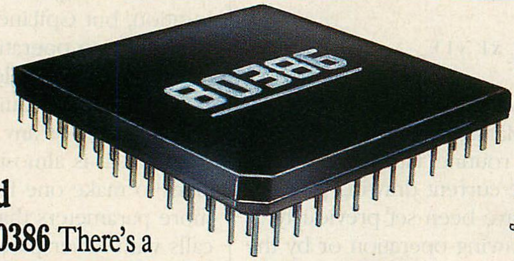
PART OF THE STANDARD

Many developers' feelings about OS/2 can be summed up as "Microsoft learned a lot from DOS and really did almost everything right this time." In a similar way, much was learned from Windows, and as a result, the Presentation Manager is a much improved environment. Given IBM's intent to standardize application and user-interface features across its product lines, it is an environment that we can expect to have with us for a long time.

Both applications developers and users will benefit from the enhancements Presentation Manager brings to OS/2, and the industry as a whole can grow into expecting a graphics interface in every 80286 and 80386 machine. But unlike Windows, the Presentation Manager even provides a friendly environment for OS/2 character-mode applications through its advanced VIO presentation support. Windows was a valiant but not entirely successful attempt at turning DOS into something it was never designed to be. On the other hand, the Presentation Manager is an outstanding example of fulfilling the design goals of OS/2 by building on top of its already powerful API and user features, and by integrating itself as a cooperative and fundamental part of the system as a whole.

Ed McNierney is principal engineer for Lotus Development Corporation. His focus is on developing graphics hardware interfaces.

A Number of Reasons A Number



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In designing PC-MOS, we knew our first priority was to exploit the minicomputer capabilities of 80386-based PCs & PS/2s. But we went further, and developed a system which would be fully compatible with the millions of existing PCs, PC ATs, and PC-compatibles. Power without sacrifice. You'd expect nothing less from the new standard bearer.

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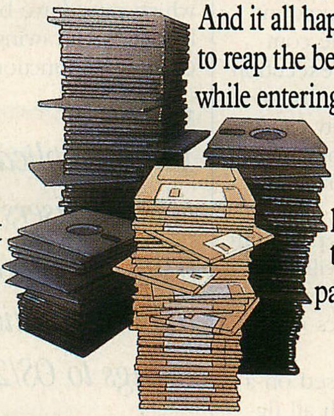

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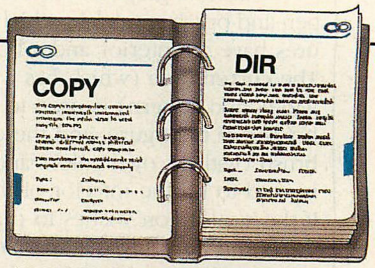

Just as you don't have to learn a whole new array of software to take advantage of PC-MOS/386,™ neither do you have to learn an entirely new set of commands.

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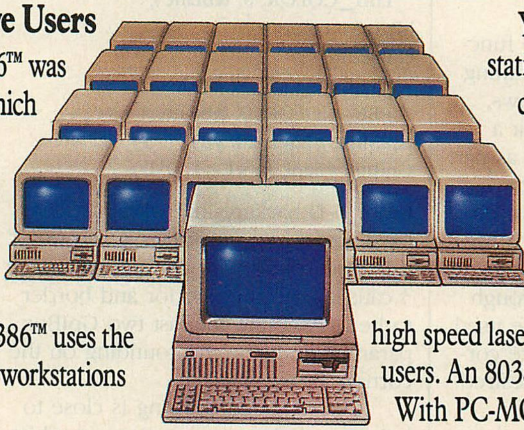
From the beginning, PC-MOS/386™ was designed as a versatile operating system which could support twenty-five users as easily as it supports one. The system comes in single, five, and 25-user modules, so you're able to start with what you need and expand when you're ready.

In a multi-user setting, PC-MOS/386™ uses the computing power of the host PC to drive workstations linked to standard RS-232 ports.



You can choose from a variety of workstations. Mix and match dumb terminals costing under $500 each with PCs and PS/2s running our terminal emulation software.

All of the host's resources can be shared. Programs, data, hard disks, tape backup units & printers (including high speed laser printers) are suddenly available to all users. An 80386-PC has minicomputer potential. With PC-MOS/386™ you can "mini" your micro.

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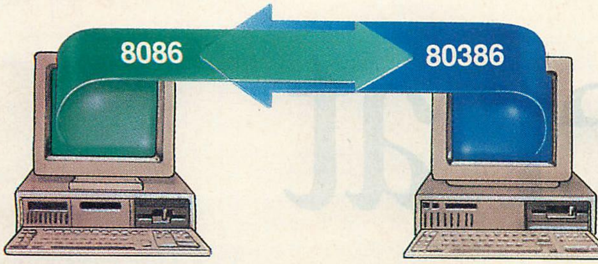

80386-based PCs & PS/2s are dual-personality computers. To run DOS programs, they act as PCs with a 640K memory limit. But to take advantage of their minicomputer capacity, they operate in true 80386 mode which lets them address up to four gigabytes of memory. PC-MOS enables the 80386-host and its workstations to independently switch between these modes–making DOS compatibility and 80386 power simultaneously possible.

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While it's true you could look elsewhere for multi-tasking, why would you want to? The *other* multi-tasking operating system is not now, nor is it planned to be, multi-user. It won't even run multiple DOS applications in multi-tasking mode.

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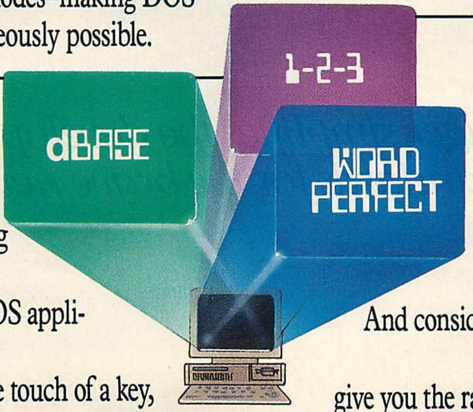

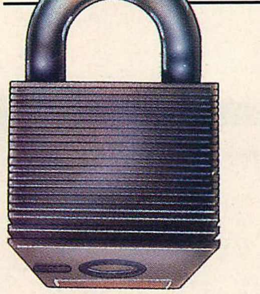

8. File/Record Locking and Security

When you decide to implement either a network or a multi-user system, there's a two-fold problem which must be solved: protecting your work from accidental misuse and securing it from intentional theft.

PC-MOS/386™ solves both aspects of this problem. Password protected security allows you to assign file, directory, and task access to each user. Plus, files and records are locked using either PC-MOS' proprietary system or NETBIOS emulation.

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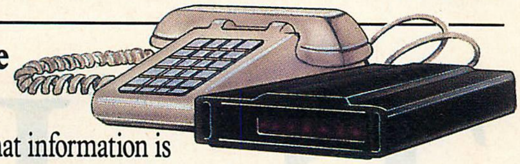

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As you evaluate operating systems, ask yourself if it's reasons you're considering...or rhyme. Ask if you're getting a system for tomorrow, or one that was made for yesterday. See if you're being forced to buy new hardware because of *their* software.

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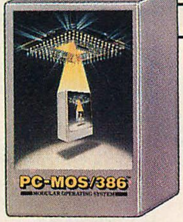

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MODULAR OPERATING SYSTEM

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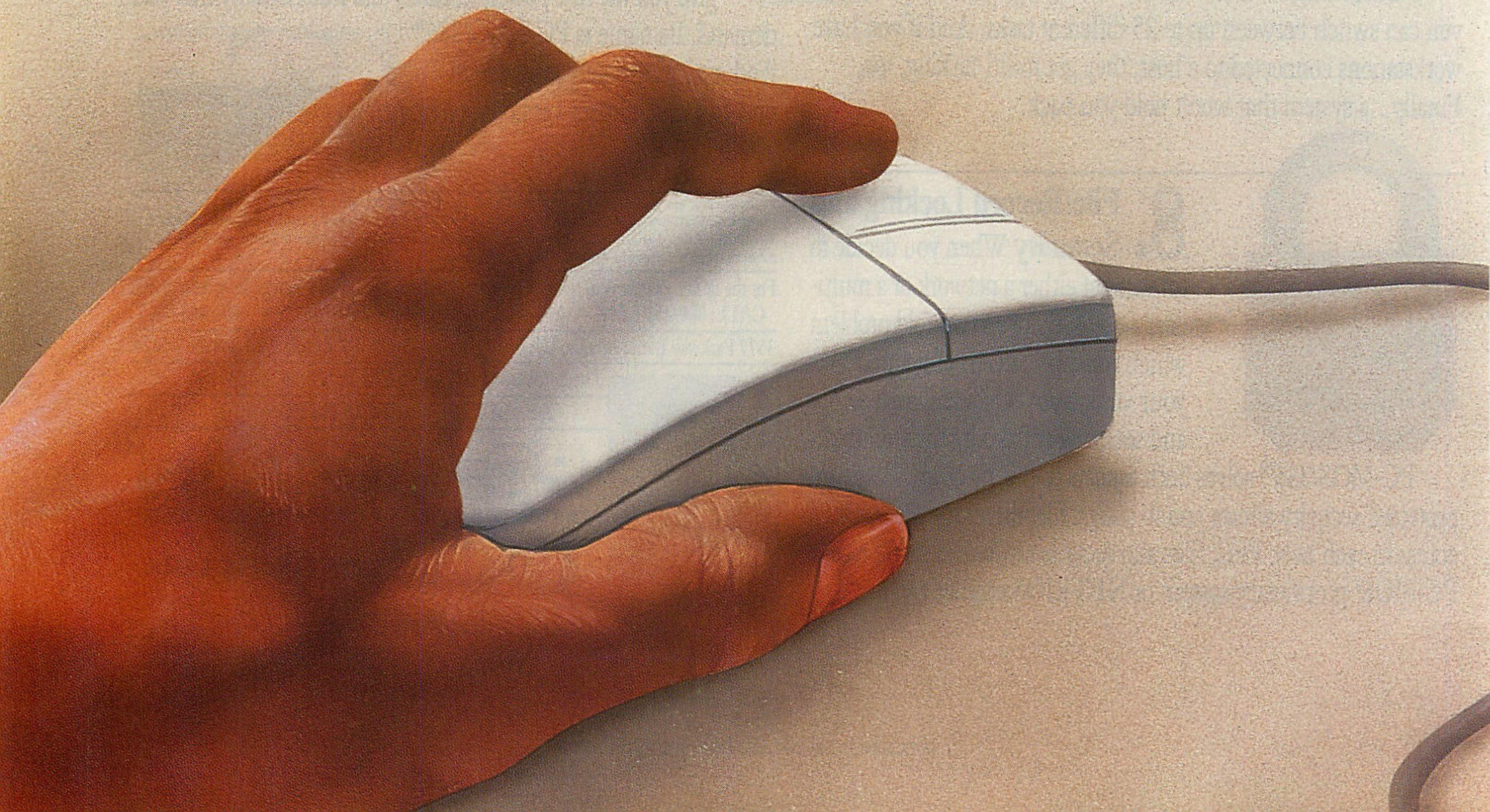
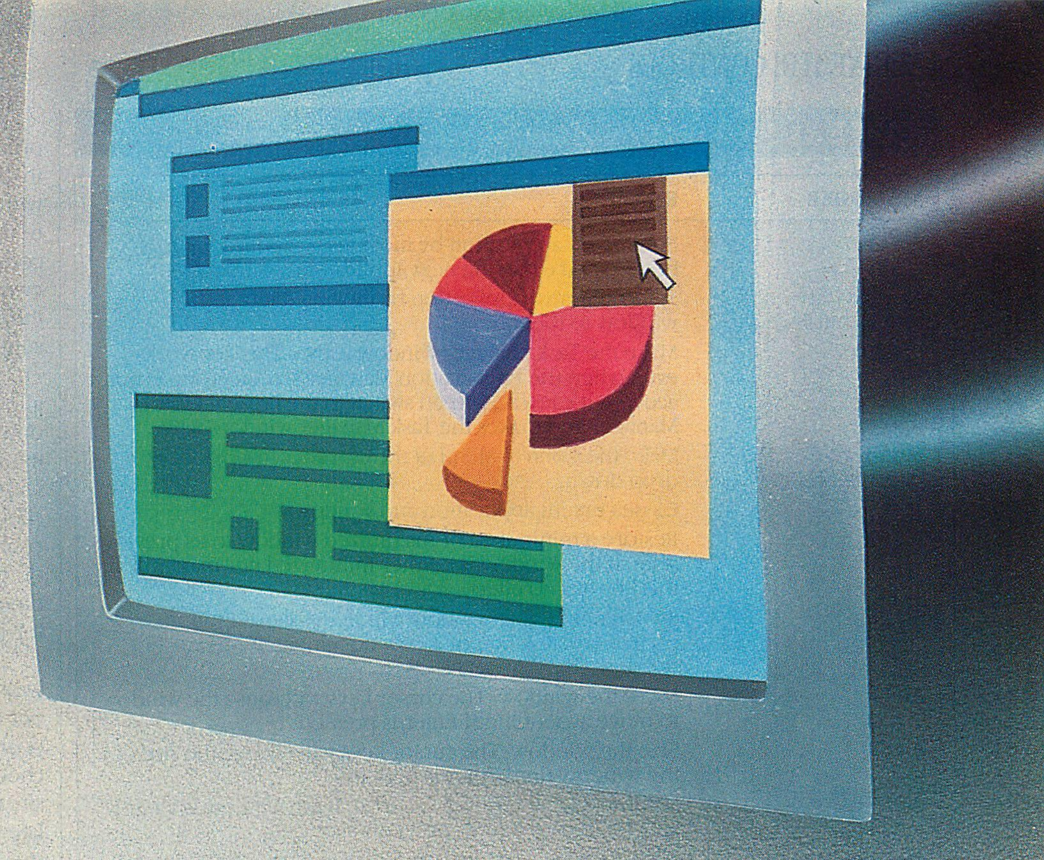
The User at the Controls

The Presentation Manager simplifies the developer's job by setting user-interface standards for the brave new world of OS/2.





ED McNIERNEY

The user interface design of the OS/2 Presentation Manager is a giant leap ahead for PC-based applications development. For the first time, an operating system extension is available that provides guidelines, support software, and an applications interface for a consistent and standard set of user-interface features.

The Presentation Manager user interface provides consistency and guidance to developers and users of Presentation Manager and OS/2 applications. It will help them navigate through unchartered territory and discover brave new worlds in applications development. Ultimately, it will ease the learning curve, allow easy movement among applications, and contribute to unsurpassed flexibility and performance.

The user interface has added importance because it is a major player in IBM's Systems Application Architecture (SAA), a plan to provide standard user and applications interfaces across all IBM hardware platforms. Although SAA is not yet as extensive and prescriptive as anticipated, it goes a long way toward helping developers avoid arbitrary software differences that frustrate users and increase training costs.

The Presentation Manager's user interface is designed for optimal user ease. It employs a multiple-choice menu structure rather than the more demanding fill-in-the-blanks approach. To allow applications software to present a consistent, predictable behavior to the user, independent of the application's purpose, the user interface manipulates the display-mode, keyboard, and mouse operations and provides tools and guidelines for application support. It also sets standard names for tasks (such as Save and Open files) that users can select from menus, and it supplies utilities (for example, the Filing System) for controlling overall behavior of the Presentation Manager system and creating customized work environments.

The Presentation Manager has learned many lessons from its DOS predecessor, Microsoft Windows. Although visibly similar to user applications provided by Windows, Presentation Manager utilities have been upgraded and enhanced. The similarity of user screens also masks radical differences in the Presentation Manager's internal structure. Most significant is a switch from cooperative multitasking of Windows to full preemptive multitasking under OS/2, which provides more flexible task scheduling (see "Windows of Opportunity," Paul Grayson, February 1987, p. 70 and "Multiple Tasks," Steven Armbrust and Ted Forgeron, November 1987, p. 90). This not only simplifies applications development but also furnishes users with a quicker response than Windows.

STANDARDIZING KEYSTROKES

The Presentation Manager routes most keyboard input directly to the application; for example, a word-processing application is given use of most keystrokes for text input and editing. But the Presentation Manager user interface saves some keystrokes for itself (see table 1) that cannot be redefined by any application. The interface uses them to communicate with the Presentation Manager and with menus and icons in the active application. (Icons in the Presentation Manager are small symbols that represent an application running without an output window.)

ILLUSTRATION • NENAD JAKESEVIC

TABLE 1: ***Presentation Manager Keystrokes***

KEYSTROKE	RESULT
Alt-Tab or Alt-Esc	Select next application by moving top application to bottom and exposing next application's window.
Alt-Shift-Tab or Alt-Shift-Esc	Select the next application by moving the bottom window to the top.
Ctrl-Esc	Make the Task Manager window active. This key works even when the Presentation Manager screen group is not active—it causes a screen switch to the Presentation Manager and makes the Task Manager window active.
Shift-Esc or Alt-Spacebar	Make the Control Menu of the current active window drop down.
Alt-F4	Close current application and window.
Alt-F5	Restore a minimized or maximized window to its previous state. If the window is neither minimized nor maximized, this key has no effect.
Alt-F6	Switch to the next window within the same application, such as a dialog box or a new document. With only one window, this key has no effect.
Alt-F7	Move the window. The cursor keys will cause the window to move around until Enter is pressed.
Alt-F8	Size the window. The cursor keys will change the size of the window until Enter is pressed.
Alt-F9	Minimize the window to an icon. If the window is already an icon, return it to its previous size.
Alt-F10	Maximize the window to full screen. If the window is full screen, return it to its previous size.
Alt or F10	Begin selection of menu items with the cursor and alphabetic keys.
WHEN A MENU IS DROPPED DOWN	
Left arrow	Move to the next menu to the left of the current menu.
Right arrow	Move to the next menu to the right of the current menu.
Up arrow	Move the highlight to the item above the one it is currently selecting.
Down arrow	Move the highlight to the item below the one it is currently selecting.
Enter	Select the highlighted menu item and execute the function associated with it.
Esc	Cancel menu operation.
WHEN A DIALOG BOX IS DISPLAYED	
Tab	Select the next active item in the dialog box, moving from left to right and top to bottom.
Shift-Tab	Select the next active item in the dialog box, moving from right to left and bottom to top.
Spacebar	Toggles state of a check box between checked and unchecked, or activates the currently selected button.
Enter	Activates the default operation associated with the default button, whether or not it is highlighted.
Esc	Cancel dialog-box operation.

The Presentation Manager receives keystrokes from the keyboard and passes most of them along to applications; certain keystroke combinations are reserved for communicating with the Presentation Manager and application menus and icons.

In addition to reserving keystrokes for system functions, the Presentation Manager application guidelines recommend (but do not require) the standard use of other keystrokes for performing standard functions (see table 2). For example, the F1 key is recommended as the standard application help, following a popular trend in many PC applications. In addition, F10, following another trend in PC programs, is recommended for switching action-bar selections, although the Alt key also works for this function.

Software developers are likely to follow recommended usages whenever possible in order to optimize the Presentation Manager's potential for providing consistency to users. Standardizing the keystrokes also helps to reduce the learning curve for Presentation Manager applications.

Some recommended keystrokes provide similar or redundant functions in an attempt to provide compatibility with older Microsoft Windows conventions, OS/2 conventions, and popular conventions not specific to any one environment. Where conflict surfaces, the Presentation Manager user interface supports all available keystrokes.

If an application is designed to allow the user to open multiple windows displaying multiple data files at the same time, the Ctrl key combined with function keys F4 through F10 should produce the same effects (close, resize, move, minimize, and maximize) on child windows as the Alt key combined with the function keys produces for the main application window.

Presentation Manager use is easiest with a mouse and a keyboard together, but many mouse operations have keyboard equivalents that allow the user to choose the fastest action in a particular situation. Keyboard operation to simulate mouse motion is left up to the specific application; the Presentation Manager does not attempt to replace a mouse with the keyboard.

PLAYING CAT AND MOUSE

Presentation Manager guidelines for mouse control are limited because mouse interaction is highly application specific. However, the user interface does recommend that the mouse pointer be shaped as an arrow and changed to an hourglass shape when the application begins a lengthy operation that suspends other user interaction with the application.

Mouse-button usage is specified for one-, two-, and three-button devices, an indication of the user interface's support for third-party hardware, considering that Microsoft and IBM sell only two-button mice. Recommended mouse usage is demonstrated in table 3. Single-button mice lack the task management and selection capabilities of two- and three-button mice. (Keyboard equivalents of these functions also are provided.) For two-button mice, clicking the two buttons together allows users to perform functions executed by the third button of a three-button mouse; a double click of the third button, however, cannot be simulated on a two-button mouse. Thus, the user employing a three-button mouse has the most flexibility.

Mouse operations inherently are simpler than keyboard operations because the mouse has far fewer buttons from which to choose. Mouse movement causes the pointer on the screen

to move; if the pointer changes shape when dragged over specific areas of the screen, this indicates that clicking or dragging the mouse over those areas will have a special effect. The cursor shape changes to an I-beam when working with text and an hourglass during lengthy operations.

Use of the keyboard can enhance mouse operations; normally clicking the mouse on a single item will select it and dragging it across a group of items (or a block of text) will select the entire group. Once a selection is made, specific keystrokes are used with the mouse to make modifications.

WHAT YOU SEE IS . . .

Separate and unrelated applications can share the display screen with each other under the Presentation Manager. An application's screen output is displayed in a window that can be overlapped, moved, enlarged, or reduced. Because Presentation Manager programs are able to run at any display resolution (including resolutions not available on any device at the time the program is released), individual applications do not need too much additional processing in order to support shared use of the display.

Windows, menus, and dialog boxes are the major players displayed on the screen by the Presentation Manager's user interface. They communicate application-specific and system-general information to users.

Window controls. Because most interaction with an application is centered on its display window, the format of the window is vital to providing a consistent appearance and operation of system controls to the user.

A simulated Presentation Manager application window is shown in photo 1. (All windows shown in this article are based on specifications from the *Microsoft Operating System/2 Software Development Kit Windows Presentation Manager Reference*.) The bulk of the window, known as the *client area*, is used by the application for its own display purposes. Controls surrounding the client area are the title bar, System Menu box, minimize box, maximize box, action bar, vertical scroll bar, horizontal scroll bar, size box, and border.

The application's *title bar* is at the top of the window. It identifies the application that is running in that window so that a desired window can be selected easily from among a stack of overlapping windows on the screen. If the application allows the user to open various data files and work with them, the name of the data file in use is appended to the name of the application; if several copies of the same application are running at the same time, the name of the data file serves to distinguish among them. In photo 1, the application SampleApp is using the data file named YourDocument. If the application is started without a data file, the title would read SampleApp (untitled) in order to remind the user that the data have not been saved.

The title bar also serves as a handle by which the window can be grabbed and moved. If the user drags the title bar around the screen with a mouse, the entire window moves.

The System Menu box is located to the left of the title bar. When clicked on with the mouse, or when the keyboard command Alt-Spacebar is typed, the System Menu drops down. It contains a standard set of commands common to all applications that allow the window to be moved or sized or to have the application terminated. Applications can add more commands to the System Menu, but the standard commands are always present.

Windows, menus, and dialog boxes are the major players displayed on the screen by the Presentation Manager's user interface.

The *minimize box* is represented by the arrow pointing downward to the right of the title bar. When this box is clicked on with the mouse, the application's window is closed down and replaced by an icon representing the application. The application continues to run but has no window to display its output. Minimizing an application is an easy way to save screen space without having to save files and close down the entire application; some applications update their icons dynamically and use them to display a small amount of data even while minimized.

The *maximize box*, which is to the right of the minimize box, contains an arrow pointing upward. When this box is clicked on with the mouse, the application's window grows to fill the entire screen, allowing the user to see as much of the application's client area as possible. When the window is maximized, the up-arrow icon is replaced by a pair of arrows pointing up and down; if the box is clicked on in this state, the application window is restored to its previous size.

The *action bar* is the line of text immediately beneath the title bar. It is here that the application places the names of the menus available to the user. Although these names might change during the course of the application to reflect features that become available and then unavailable, the menu items themselves always appear in the same place in the action bar.

Clicking on an action-bar item with the mouse causes the menu associated with that item to drop down over the client area and become ready for use. Menu items also have associated *accelerators*, which are keystrokes that allow the menu to be selected without using the mouse. Each word on the action bar has one of its letters underlined; by holding down the Alt key and pressing the letter indicated, the menu can be made to drop down and become active. Pressing the Esc key or clicking with the mouse outside the menu causes the menu to disappear from the screen.

The *vertical scroll bar* runs the length of the right side of the window. Although not all applications use scroll bars, they are the standard method for moving around in the application's display area when the total display is larger than the window's client area. The *up arrow* at the top and the *down arrow* at the bottom of the screen allow the user to scroll the display up or down by a small amount each time the arrow is clicked on with the mouse. If the mouse button is pressed and held while the pointer is on a scroll arrow, scrolling continues until the button is released.

Each application controls the amount of movement caused by clicking on the arrows; for text applications, the amount is usually one line. The *scroll box* or *elevator* moves up and down the scroll bar to indicate the user's current position in the display; when at the top of the bar, data displayed in the client area mark the beginning of the application's total display. Clicking in the scroll bar above and below the scroll box works in a similar manner to clicking on the scroll arrows, except that it causes larger movements across displayable data; typically, it moves the display by one full window. Like scroll arrows, holding the mouse button with the pointer in either the up or down region of the

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C served us well in the days of kilobytes and kilohertz. It was the only language we could implement efficiently on our newborn microcomputers. But with today's mega-machines, shouldn't we demand more from our compilers?

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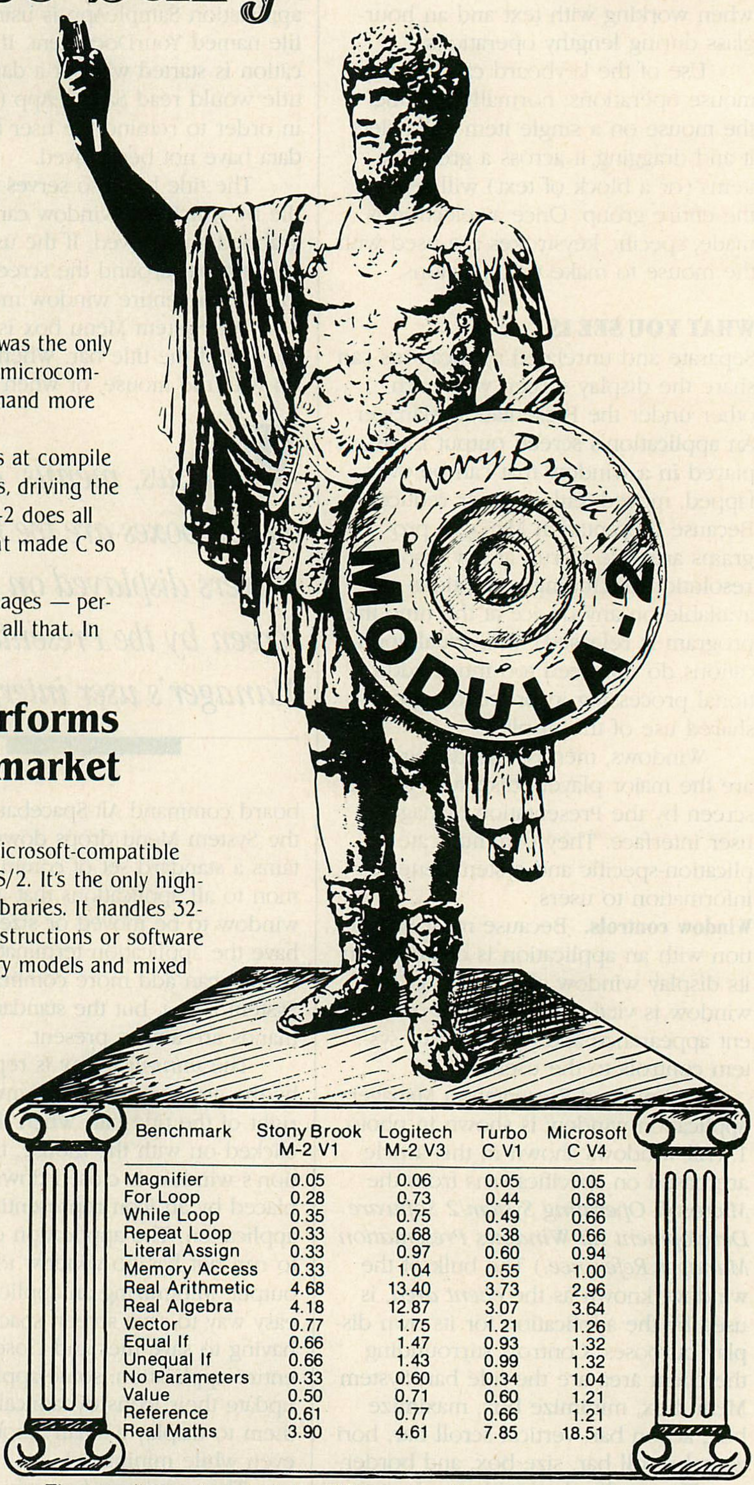

Benchmark	Stony Brook M-2 V1	Logitech M-2 V3	Turbo C V1	Microsoft C V4
Magnifier	0.05	0.06	0.05	0.05
For Loop	0.28	0.73	0.44	0.68
While Loop	0.35	0.75	0.49	0.66
Repeat Loop	0.33	0.68	0.38	0.66
Literal Assign	0.33	0.97	0.60	0.94
Memory Access	0.33	1.04	0.55	1.00
Real Arithmetic	4.68	13.40	3.73	2.96
Real Algebra	4.18	12.87	3.07	3.64
Vector	0.77	1.75	1.21	1.26
Equal If	0.66	1.47	0.93	1.32
Unequal If	0.66	1.43	0.99	1.32
No Parameters	0.33	0.60	0.34	1.04
Value	0.50	0.71	0.60	1.21
Reference	0.61	0.77	0.66	1.21
Real Maths	3.90	4.61	7.85	18.51

The compiler package includes DOS runtime library objects and full sources for our split-screen text editor for $195. The development package includes all of the above plus an automatic make utility, a symbolic debugger, and run-time library sources for $345. MasterCard and Visa accepted. Add $5 for shipping in North America, $25 for overseas shipping.

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scroll bar causes scrolling; this action is useful for moving rapidly through a large display or data file.

The *horizontal scroll bar* at the bottom of the window works the same as the vertical scroll bar, except that it causes movement to the right or the left across the display. An application can have one or both scroll bars present, or none at all.

The *size box* is the small square area at the lower right corner of the window where scroll bars meet if the application window has both a horizontal and a vertical scroll bar. The size box provides a handle by which the lower right corner of the window can be moved in order to change the window's size on the display.

The *border* is the narrow band surrounding the entire window. It highlights the window against its background and, along with the mouse, controls both the size and position of the application window. The border is broken into eight regions by thin lines running through it; these regions correspond to the four corners and four sides of the window. When the mouse cursor, normally a pointing arrow, moves over each of these eight regions, its shape changes to a double-headed arrow pointing in two directions. The border can be stretched by dragging it with the mouse within that region. Dragging one side of the window allows only that side to be moved in and out, whereas dragging a corner with a mouse causes the two sides that meet in that corner to move.

Multiple menu items. Menu items fall into several categories of operation that can be distinguished by the menu's appearance on the display. Any item that executes a single command without requiring user input appears in the menu as a word or set of words on a single line (such as New or Save in photo 2). When these are selected from the menu (by clicking on them with the mouse or highlighting them with a cursor key and pressing Enter) the commands are executed.

Extended menu items require more information from the user. The Save As . . . menu item allows the user to save the current data file under a new name, which must be entered for the operation to complete. The ellipsis (. . .) following the menu item tells the user that more information will be requested through use of a dialog box. The dialog box should always have a Cancel option available so that the entire command can be aborted if the wrong menu selection is made.

TABLE 2: ***Recommended Keystroke Usage***

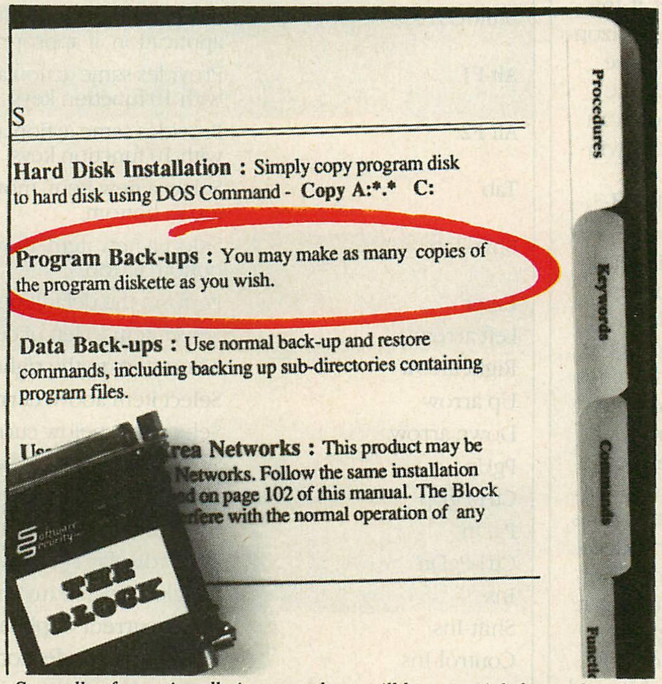
KEYSTROKE	RESULT
F1	Help. Display whatever help system that is available in the application.
F6	Move to the next area of the current window, if appropriate, moving clockwise.
Shift-F6	Move to the next area of the current window, if appropriate, moving counterclockwise.
Ctrl-F6	Select the next data-file window in use by the current application, if appropriate, moving front to back.
Shift-Ctrl-F6	Select the next data-file window in use by the current application, if appropriate, moving back to front.
Alt-F1	Provides same action as the F11 key for keyboards with 10 function keys.
Alt-F2	Provides same action as the F12 key for keyboards with 10 function keys.
Tab	Select a new item, moving from left to right and top to bottom.
Shift-Tab	Select a new item, moving from right to left and bottom to top.
Enter	Perform the default operation.
Left arrow	Select item to left of current item.
Right arrow	Select item to the right of current item.
Up arrow	Select item above current item.
Down arrow	Select item below current item.
PgUp	Scroll display up one window full.
Ctrl-PgUp	Scroll display left one window full.
PgDn	Scroll display down one window full.
Ctrl-PgDn	Scroll display right one window full.
Ins	Toggle between Ins and Typeover mode.
Shift-Ins	Insert current Clipboard contents.
Control-Ins	Copy current selection to Clipboard.
Backspace	Delete character to left of selection.
Alt-Backspace	Undo the previous operation.
Del	Delete the selected item.
Shift-Del	Copy the selected item to the Clipboard and delete it.
Ctrl-Del	Delete from selection to end of the line.
Shift-Up arrow	Extend selection upward from current item.
Shift-Down arrow	Extend selection downward from current item.
Shift-Right arrow	Extend selection right from current item.
Shift-Left arrow	Extend selection left from current item.
Ctrl-Up arrow	Move cursor up without changing selection.
Ctrl-Down arrow	Move cursor down without changing selection.
Ctrl-Right arrow	Move cursor right without changing selection.
Ctrl-Left arrow	Move cursor left without changing selection.
Home	Move selection to beginning of line.
Ctrl-Home	Move selection to beginning of document.
Shift-Home	Extend selection to beginning of line.
Shift-Ctrl-Home	Extend selection to beginning of document.
End	Move selection to end of the line.
Ctrl-End	Move selection to end of document.
Shift-End	Extend selection to end of the line.
Shift-Ctrl-End	Extend selection to end of document.

In addition to reserving certain keystrokes, the Presentation Manager specifications recommend the use of certain keys for common functions to provide consistency among applications (their use, however, is not required). For example, the F1 key is suggested for requesting help, and F10 is recommended for switching action-bar selections. The Alt key also can be used to switch selections.

"How to protect your software by letting people copy it."

By Dick Erett, President of Software Security

Inventor and entrepreneur, Dick Erett, explains his company's view on the protection of intellectual property.



Soon all software installation procedures will be as straightforward as this. The only difference will be whether you include the option to steal your product or not.

"A crucial point that even sophisticated software development companies and the trade press seem to be missing or ignoring is this:

Software protection must be understood to be a distinctively different concept from that commonly referred to as copy protection.

Fundamentally, software protection involves devising a method that prevents unauthorized use of a program, without restricting a legitimate user from making any number of additional copies or preventing program operation via hard disk or LANs.

Logic dictates that magnetic media can no more protect itself from misuse than a padlock can lock itself.

Software protection must reside outside the actual storage media. The technique can then be made as tamper proof as deemed necessary. If one is clever enough, patent law can be brought to bear on the method.

Software protection is at a crossroads and the choices are clear. You can give product away to a segment of the market, or take a stand against the theft of your intellectual property.

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We strongly believe that giving your software away is fine, if you make the decision to do so. However, if the public's sense of ethics is determining company policy, then you are no longer in control.

We have patented a device that protects your software while allowing unlimited archival copies and uninhibited use of hard disks and LANs. The name of this product is The BLOCK™.

The BLOCK is the only patented method we know of to protect your investment. It answers all the complaints of reasonable people concerning software protection.

In reality, the only people who could object are those who would like the option of stealing your company's product.

"...eliminating the rationale for copy-busting..."

Since The BLOCK allows a user to make unlimited archival copies the rationale for copy-busting programs is eliminated.

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The BLOCK attaches to any communications port of virtually any microcomputer. It comes with a unique customer product number programmed into the circuit.

The BLOCK is transparent to any device attached to the port. Once it is in place users are essentially unaware of its presence. The BLOCK may be daisy-chained to provide security for more than one software package.

Each software developer devises their own procedure for accessing The BLOCK to confirm a legitimate user. If it is not present, then the program can take appropriate action.

"...possibilities... limited only by your imagination..."

The elegance of The BLOCK lies in its simplicity. Once you understand the principle of The BLOCK, hundreds of possibilities will manifest themselves, limited only by your imagination.

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TABLE 3: *Recommended Mouse Usage*

ACTION	RESULT
Mouse movement	Moves pointer around the screen.
BUTTON 1	
Click[a]	Selects item under the pointer.
Shift-Click	Extend selection from last item selected to the current mouse position.
Ctrl-Click	Select discontinuous items; keep current selection and add new item to it.
Double click[b]	Select item and perform default action.
Shift-Double click	Extend selection from last item selected to current mouse position and perform default action on all selected items.
Drag[c]	Drag selected object around the screen.
Shift-Drag	Extend selection from last item selected to the point where mouse button is released.
Ctrl-Drag	Select discontinuous items; keep current selection and add newly selected area to it.
BUTTON 2	Usage defined by application.
BUTTON 3	
Click	Transfer control to Task Manager.
Double click	Transfer control to the next task.

[a] *Click: a quick press and release of a mouse button.*
[b] *Double click: pressing and releasing a mouse button twice in rapid succession.*
[c] *Drag: holding down a mouse button while moving the mouse.*

Although the Presentation Manager provides keyboard-only equivalents for mouse functions, powerful Presentation Manager services can be accessed quickly and easily using a combination of mouse and keyboard. Mouse-button usage is specified for one-, two-, and three-button devices, with the last being the most flexible.

Some menu items represent selection settings made by the user: a Toggled Selection is a single item that is turned on or off, while a Selection Group displays a number of related items, only one of which can be chosen at a time. In photo 2, the Autosave On menu item is an option currently in effect, indicated by the check mark; if the menu item is selected again, the option is turned off and the check mark removed. The Save options (Save Text, Save Format, Save Entire) are a selection group; as such, one option must be active but no more than one can be selected. A check mark appears next to the active option.

The menu items' accelerators (mnemonic keys) allow the user to go directly to that menu item by pressing the appropriate letter key. The letter key is almost always one of the letters in the menu item and is identified by an underline below it. Accelerators sometimes allow a special keystroke to duplicate the function of a menu item. For example, the Shift-Del key combination might perform the same operation as the Cut selection from an Edit menu: to delete the currently selected data. When this occurs, the name of the key or key combination is displayed to the right of the menu item.

Dialog boxes. Dialog boxes allow a set of information that is required for a particular process to be gathered in a single operation. They are forms that are filled out with data and then sent to the application for processing. Data can be supplied in any order, and selections can be edited or adjusted before the application receives the data to complete the command.

Because dialog boxes are the chief form of user input other than the main application window, they are divided into different levels of importance (application or system). *Modeless dialogs* are not urgent; the user can open other application windows before completing them. *Application modal dialogs* must be completed before the application can continue, but they do not prevent the user from selecting another application. *System modal dialogs* stop everything; they must be completed before anything else can be done. System modal dialogs usually are displayed only for the most drastic system error conditions.

Users cannot move modal dialog boxes out of the way. They pop up on top of windows on the screen and remain until the user fills them out. Modeless dialog boxes can be moved or hidden by other windows until the user decides to complete them. To distinguish them visually, application and system modal dialog boxes have framed borders but no title bar for moving them. Modeless dialog boxes have a title bar and a System Menu; the only items normally available on the System Menu are Move and Close.

Dialog boxes consist of dialog items called *controls* (see table 4). When multiple push-button controls are available in a dialog box (typically at least two, OK and Cancel, are provided), one of them has a thicker border around it; this button indicates the default action for that box. Pressing the Enter key executes this action. Because the default action is almost always OK, pressing Enter usually has the effect of ending the dialog. When working with either push-button or check-box controls, the Space Bar is used to select the appropriate button and execute the command associated with it or toggle the state of the box.

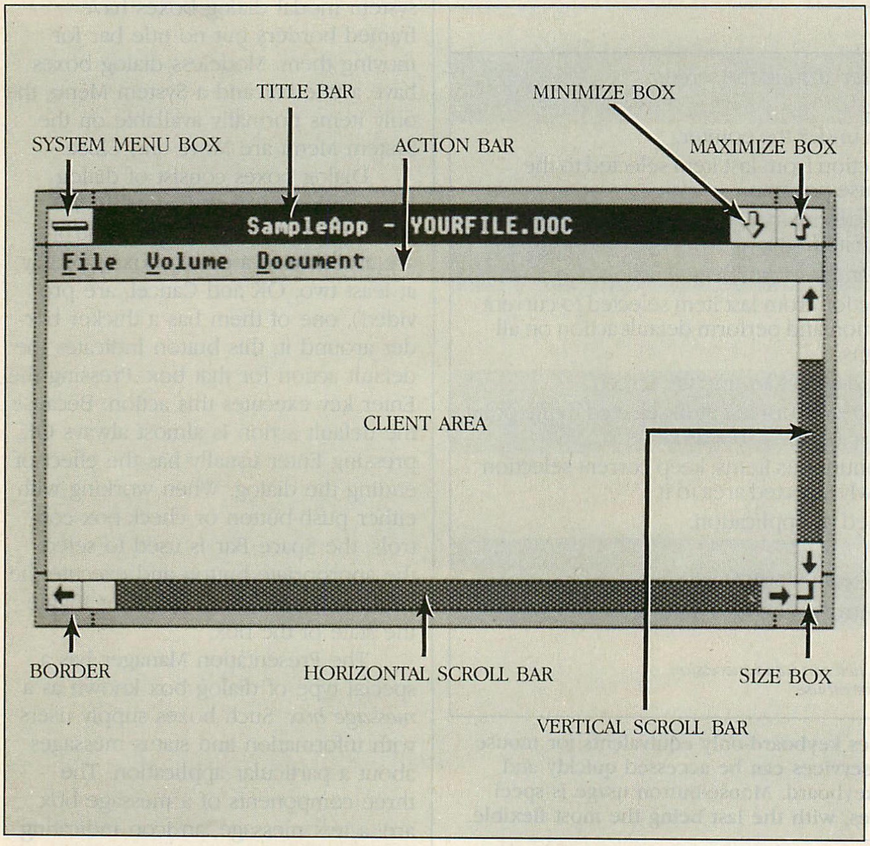
The Presentation Manager has a special type of dialog box known as a *message box*. Such boxes supply users with information and status messages about a particular application. The three components of a message box are: a text message, an icon indicating the criticality of the message, and a set of push buttons for choosing an action. If the message is informative in nature (for example, Printing Complete), then OK is the only button needed; pressing it acknowledges the message. Other messages might require a choice, such as OK or Cancel for responding to a disk driver error.

Because dialog boxes (and therefore message boxes) normally occupy a portion of the application's client area, they cannot be displayed when the application has been minimized to an icon. Because most dialog boxes are displayed as a result of menu item selection (which also cannot be performed on an icon), this is rarely a problem. However, when message boxes report status or event information that occurs without user input, they need to be displayed by opening the application to a window on the screen. To inform the user that a message is available from a minimized application, the application's icon flashes. Double-clicking on the flashing icon opens it into a window that is overlaid by the message box.

ENHANCING THE SYSTEM

Basic operation of the Presentation Manager is enhanced by a number of utility applications. These utilities pro-

PHOTO 1: *Application Window*



Most of the application window is available for output display; called the client area, it is surrounded by mechanisms for controlling it and the application. All sample windows in this article are based on specifications in *Microsoft Operating System/2 Software Development Kit Windows Presentation Manager Reference*.

TABLE 4: *Dialog Box Controls*

CONTROL	DESCRIPTION
Push button	Button that, when selected, executes a particular command.
Radio button	One of a set of buttons, only one of which might be selected at a time. The name derives from their resemblance to car-radio push buttons.
Check box	Option or selection that might be active or inactive.
List box	Box containing a list of names (such as file names) from which one or more can be chosen.
Edit control	Box in which the text can be entered and edited.

Controls are available for use in dialog boxes that allow the text to be entered, various items to be selected from lists, and options to be turned on or off.

vide access to help information, disk and file manipulation, overall system parameters, and general user functions. While they are not productivity applications in themselves, they provide a means for the Presentation Manager user to configure and work with the application software.

The help facility. Help provides on-line information about the operation of the user shell. Help is requested by pressing the F1 key, or clicking on the F1 = Help area of the action bar.

In response to the help request, a secondary window is displayed that contains information about the currently selected item. If more than one item is currently selected, the help window provides information related to the specific item on which the selection cursor is actually situated.

General help, an index of available topics, and information on the functions assigned to specific keys are available in addition to help on the currently selected item. This information is requested by pressing F1, F5, or F9 respectively, once the help window has been displayed on the screen.

The help window can be both moved and sized. It also contains a vertical scroll bar, which is used to scroll through the help information if it is too long to fit in the window.

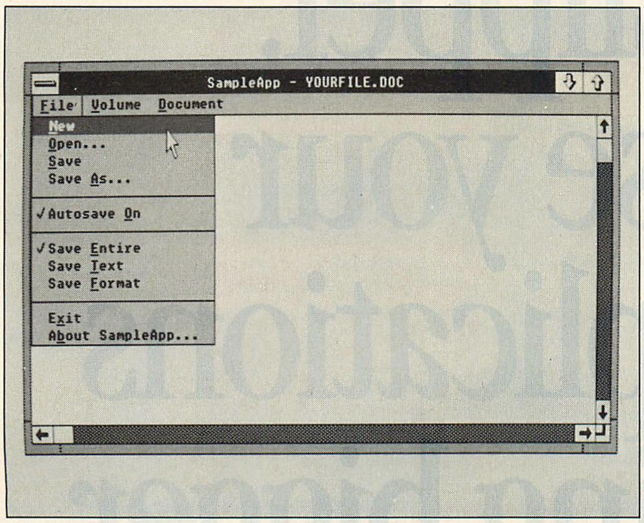
If an application is minimized while help is being displayed, the help window is removed. If help is required when the application is restored, it must be selected again.

The clipboard. The electronic clipboard is the Presentation Manager's mechanism that allows users to move information from one application to another. The user can extract information from an application by selecting it with cursor keys or with the mouse, then moving (copy and delete) the information or copying it to the clipboard. After switching to another application, the user can then "paste" the contents of the clipboard into that application as if they were typed keystrokes or mouse-drawn graphics.

The clipboard can handle data in a wide variety of formats, including plain text, text with formatting and attribute information included, graphic bitmap data, compressed-image information, or any application-defined format. When an application copies its data onto the clipboard, it also copies a description of the format in which the data are stored. The receiving application can examine the format before trying to copy the data; if the data are not in a format understood by the receiver, the instruction to copy the data is ignored and an informative message is displayed. For example, a graphic bitmap copied from the drawing program is not appropriate for pasting into a cell of a spreadsheet, although a number generated on the output display of a calculator might be accepted.

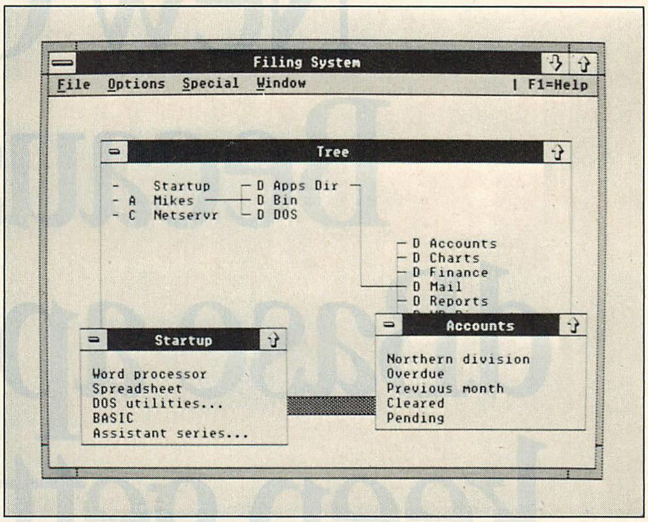
The Filing System. Unlike Microsoft Windows, the Presentation Manager user interface provides two distinct file-management utilities: the Filing System, which tracks files and directories, and the Startup Editor, which creates and updates a display of available and in-use applications. The Filing System is the logical descendant of the MS-DOS Executive from Microsoft Windows. The system has been enhanced to include many of the file and directory manipulation functions popular on Apple Computer's Macintosh, although the Filing System provides these functions in a format consistent with the appearance of applications developed under the Presentation Manager.

PHOTO 2: *Pull-down Menu*



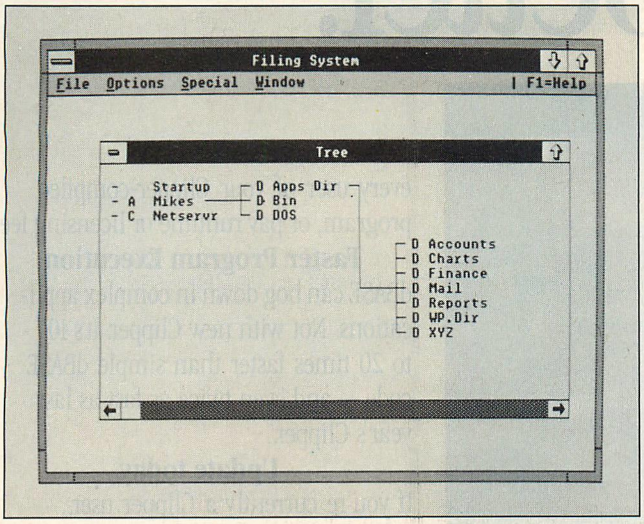
Pull-down menus contain lists of actions that the user can select to be performed. These menus are pulled down using either the mouse or a combination of keystrokes.

PHOTO 4: *Filing System Filing Windows*



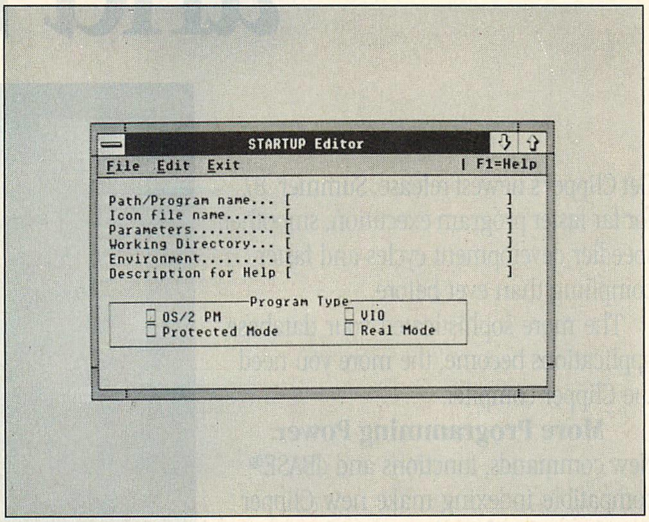
Filing windows can show the contents of directories, which are easily copied, moved, or deleted; utilities are provided for disk initialization and maintenance and file printing.

PHOTO 3: *Filing System Tree Display*



The Filing System improves upon the functions in Windows MS-DOS Executive. In addition to the usual services, it can display a tree that shows a disk's directory structure.

PHOTO 5: *Startup Editor*



The Startup Editor is used to create lists of available applications, including any explanatory prompts and icons that are used with the application when it is on screen.

In addition to file and directory manipulation services, the Filing System allows the user to view a tree diagram that shows the subdirectory structure of all system disk drives, either local or remotely connected through a network (see photo 3). The filing windows not only show the tree diagram, but also list the actual file contents of directories; these can be opened and the contents of the directories copied, moved, or deleted (see photo 4). Files displayed in the filing windows can have long, descriptive names rather than the more restrictive OS/2 file names. Mouse selection and dragging techniques allow the files to be manipulated across directories either individually or in selected groups.

The Filing System also provides disk and system management utilities, allowing the user to format diskettes and hard disks, create and destroy subdirectories, and print files.

The Startup Editor. The Startup Editor, the second file-management utility, is the Presentation Manager equivalent to the OS/2 Program Selector's editing commands (see photo 5).

With the Startup Editor, users can create their own lists of available applications, with explanatory long prompts and custom icons to be displayed when the application is on screen. Most Presentation Manager applications, however, will not require user setup because all Startup Editor functions are available to other programs through the Presentation Manager application program interface (API) (see "A Consistent API," Michael Bentley, p. 78). By providing an installation utility with application software, vendors can directly update the user's startup files and add their applications.

Applications also can be gathered into program groups in which several programs are stored in the same direc-

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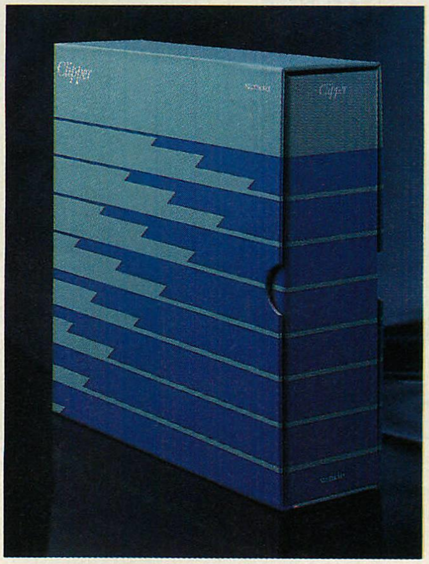

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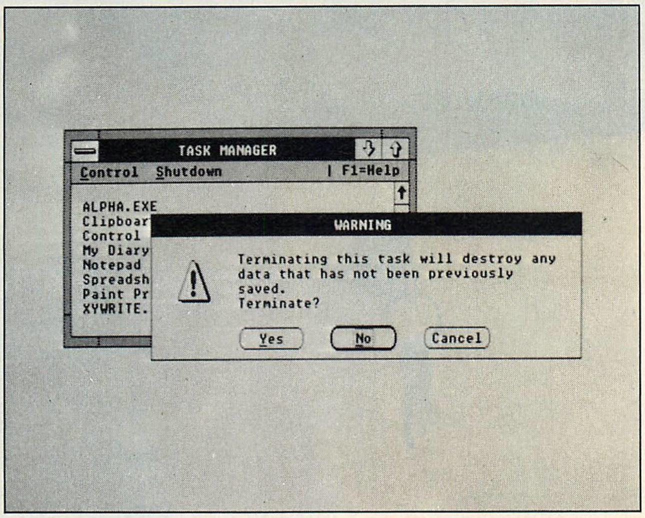
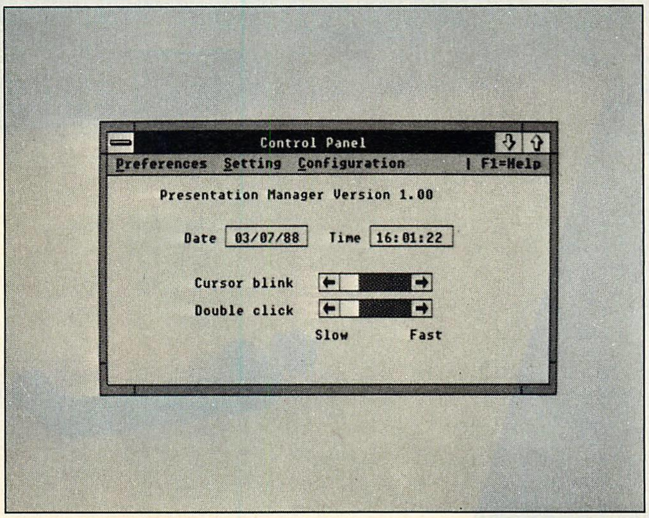
PHOTO 6: ***Task Manager***



The Task Manager provides full control of task execution, including the ability to destroy and terminate a task without going through the application's normal exit routines.

PHOTO 7: ***Control Panel***



The Control Panel is similar to that of Windows; it allows cursor blink rate, mouse-click sensitivity, and other user-preference and device-configuration options to be specified.

tory and started together using a single command. Because the Presentation Manager provides and enhances OS/2's interprogram communications, it becomes more logical for complex applications to consist of a family of cooperative programs that send data to each other as they operate.

Users can start applications by selecting associated names or icons from the Startup Editor's display. The applications listed in the display can include any OS/2 application, not just applications developed under the Presentation Manager. The Startup Editor creates a new screen group for a non-Presentation Manager application and then starts the application.

The Task Manager. This utility provides a superset of services available in the OS/2 Program Selector screen. The Task Manager maintains the entire list of active applications, including character-mode (non-Presentation Manager) applications. When the Presentation Manager screen group is active, all non-Presentation Manager applications are displayed as icons.

The Task Manager allows the user to jump among available applications without switching through the list until the correct one is selected. When an application is selected in the Task Manager window, it is moved to the top of the stack of windows on display and starts receiving keyboard and mouse input. If the selected application is a character-mode application, the system accesses the screen group and brings the application to the foreground. The Task Manager is available at all times; a switch to the Presentation Manager screen group is made if this is needed in order to display the Task Manager's selection window.

The Task Manager also allows the user to destroy and terminate applications without using the application's normal exit procedures. Although doing so can cause the application to lose all data that have not been saved, this facility is convenient when dealing with applications that have gone astray and cannot be terminated in the normal manner (see photo 6).

One of the Task Manager's major improvements over Microsoft Windows or native OS/2 is its ability to save the current state of all applications and windows on the screen so that they can be restored when the system is restarted. For users who have complex screen layouts or work with the same applications each time they use their computers, this feature saves a lot of time and annoyance in reorganizing work otherwise encountered every time they initialize their systems.

The Control Panel. The Presentation Manager Control Panel allows users to customize Presentation Manager operations by adjusting system parameters. Screen display colors, cursor blink rate, and mouse-click sensitivity can be specified. In addition, fonts or printer drivers, each possibly purchased after the system is originally configured, can be added (see photo 7).

Configuration information is stored in the PRESSERV.INI data file, which is the Presentation Manager equivalent of the WIN.INI file used by Windows. Unlike the WIN.INI file, PRESSERV.INI is not a text file and therefore cannot be edited by the user with a standard text editor. Because application programs have access to the PRESSERV.INI file through the Control Panel's utility functions, they can register and store private configuration information in it without requiring the Control Panel to understand their data formats.

INVESTING IN TOMORROW

For users unfamiliar with Microsoft Windows, the Presentation Manager user interface requires a reasonable amount of learning effort. Some of its features are natural and intuitive, such as mouse movement and selection, while others, like the keyboard, with its random-key assignments, require the same rote learning as the older MS-DOS applications required.

The additional effort is worth the utility gained, however; unlike character-mode applications, most Presentation Manager applications use the same keystrokes and menu selections to perform similar operations, and a single investment in learning one application (such as the standard utilities shipped with the system) can be applied across the board to many other programs. As IBM standardizes its systems software to SAA, users can expect their learning investment in the Presentation Manager user interface to serve them on mini and mainframe systems as well.

Ed McNierney is a principal engineer at Lotus Development Corporation. His focus is on developing graphics hardware interfaces.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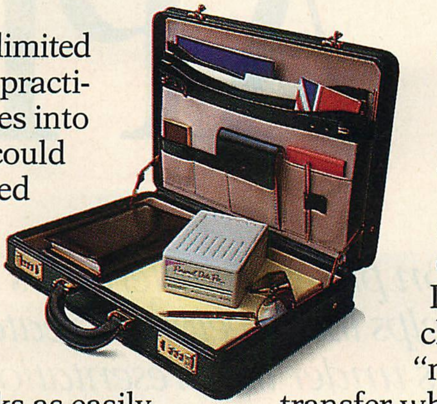

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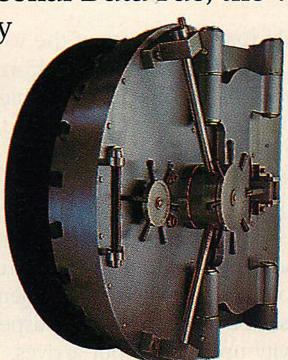

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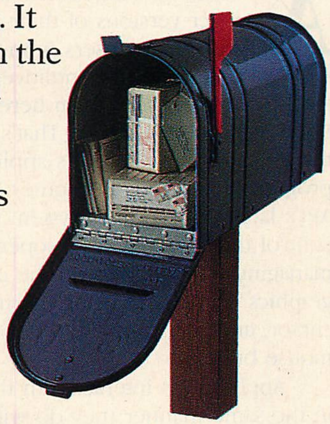

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A Consistent API

The application program interface's large collection of system services helps the developer create device-independent graphics under the Presentation Manager.

MICHAEL BRIAN BENTLEY

After running OS/2 Presentation Manager versions of their applications, many users immediately will see benefits of the intuitive interface. But to get there from here, developers will need a leg up. That's where the Presentation Manager's application program interface (API) comes in. The API's large collection of system services control the specialized I/O operations: managing the windows on the display, graphics printing, tracking the mouse cursor, and reporting the status of the mouse buttons.

Applications interact with the API in the same manner they do with the standard OS/2 API, via function calls with normal parameter lists, as if dealing with a standard C or Pascal routine library. (For a description of the OS/2 API, see "The Flexible Interface," David A. Schmitt, November 1987, p. 110.) The internal consistency and power of the API software makes it worthwhile, for reasons of both economics and performance, to use these routines as a common resource for applications, rather than writing your own set.

The number of function calls in the Presentation Manager API dwarfs the number of function calls in the OS/2 API. The major categories of API services include the following: the user shell, window management, input handling, output support, and the graphics programming interface (GPI). With the exception of the GPI, the Presentation Manager API resembles the API provided by Microsoft Windows through versions 2.x.

APPLICATION ARCHITECTURE

The organization of a Presentation Manager-compatible program results from the asynchronous input capability that is inherent in an interactive multitasking system. Unlike standard applications, Presentation Manager applications have code that handles I/O in the center, root, highest, or most significant positions in the program's hierarchy of modules.

Programs with no realtime requirements initiate an I/O request and then wait patiently for input or completion of output. They are organized so the code that does most of the work, which is typically the code performing computations or other algorithmically intensive labor, is centralized, and the I/O routines hang off of branches of the program's structure.

A Presentation Manager program differs in two major respects. First, it must be prepared to accept and react to unsolicited input. Second, when it does ask for input, it cannot suspend all activity until that input arrives. This kind of a program does not control its I/O events but instead is driven by them. Consequently, the environment handles all I/O centrally.

When a Presentation Manager application starts up, it notifies the system of its command structure, turns on the menu bar in a window, and then effectively goes to sleep. The environment handles any user interactions for the application—the code for requesting and receiving input rests in the operating system, and is not scattered throughout the application. Furthermore, this structure imposes another level of centralization within the appli-

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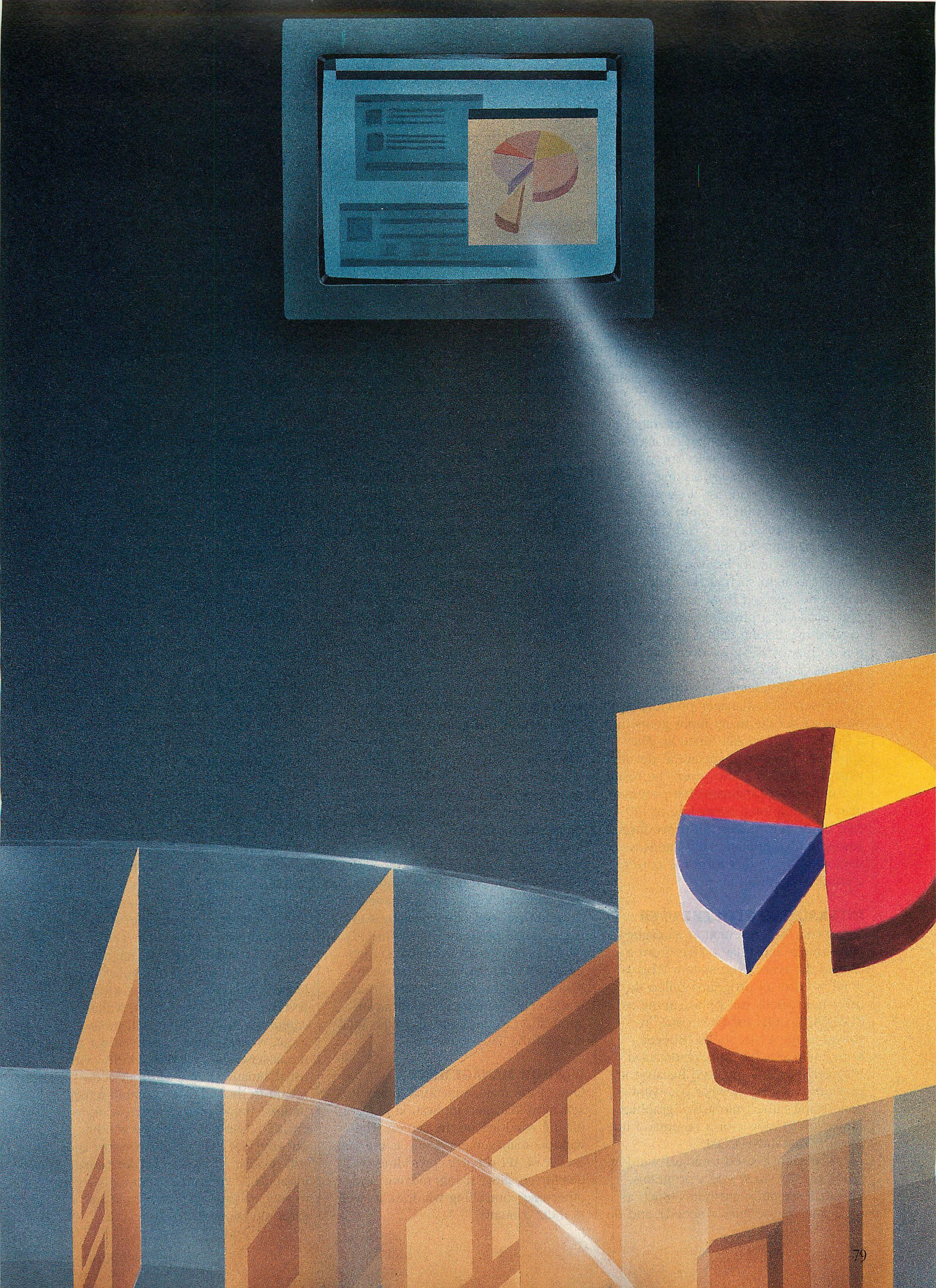

TABLE 1: *Predefined Window Classes*

CLASS NAME	DESCRIPTION
WC_FRAME	Regular top-level window with frame
WC_DIALOG	Normal dialog box
WC_BUTTON	Control buttons and checkboxes
WC_EDIT	Editable test field
WC_STATIC	Display-only titles and icons
WC_LISTBOX	List of selectable text strings
WC_MENU	Menu window
WC_SCROLLBAR	Scrollbar window
WC_MINMAXBOX	Minimize/maximize pushbuttons
WC_SIZEBORDER	Window sizing control

An application can create windows in any of these predefined classes, or it can create its own customized classes. All windows in a class share one window procedure.

TABLE 2: *Window Class Styles*

STYLE NAME	DESCRIPTION
CS_SAVEBITS	Saves overlaid image when creating window
CS_SIZEREDRAW	Redraws content of window when resized
CS_SYNCPAINT	Synchronously repaints this window
CS_PARENTCLIP	Uses parent window's visible region for clipping

An application can assign any combination of these styles to a customized window class. The style names are predefined constants; the desired ones are ORed together to form a value that is passed to the WinRegisterClass function.

cation. All input messages generated by user interaction with a particular onscreen window are sent to one procedure within the application that owns that window. In contrast, a standard application has calls to input routines, and procedures to process the resulting input, scattered throughout.

Input to an application can be a single data item such as the index of a command selected from a menu or the on/off state of a push-button control toggled by clicking with a mouse button. In many cases, however, input consists of a list of items—for example, command parameters. For these cases, the Presentation Manager provides a means to bundle many input items into a single call to an API function. The application must still specify in detail what it wants done; however, the result is a much more maintainable program than the traditional sprinkling of I/O calls and input processing procedures among the computationally intensive sections of code that form the core of a standard application.

INTERACTING WITH THE USER

Somehow, the Presentation Manager must accept and relay orders from a user to the rest of the system. This is done by a set of programs called the user shell. Shells can be as simple as COMMAND.COM for DOS or as involved as the UNIX shells (Bourne, Korn, and C-Shell). The Presentation Manager's shell is involved because it provides ways to say what you want done using either interactive graphics, similar to Windows, or a command line as with COMMAND.COM.

The shell is used to adjust window positions and sizes, select programs, adjust presentation attributes (such as color and mouse cursor speed), and do the essential file operations (copy, rename, erase). This shell embodies the capabilities of print control and the interactive transfer of graphics and other data from one program to another using a clipboard, or *cut buffer*. The shell contains these operations because they are properly the province of a privileged program working as an agent for the operating system. (For a description of the user's view of the shell, see "The User at the Controls," Ed McNierney, this issue, p. 64.)

A primary component of the Presentation Manager's user shell is the Task Manager, which is a utility that presents a list of installed programs that the user can launch, as well as a list of programs that are already running. One of the installed programs is always the operating system's command processor, which in turn allows any other program, whether it is installed or not, to be started.

The shell-related API services allow applications to interact with the Task Manager in much the same way the user can with keyboard and mouse. A program can add other programs to the installed program list, inquire which programs are running, launch new programs, and switch between running programs. These services are comprehensive enough to allow an application to duplicate all of the functions of the Task Manager.

WINDOW MANAGEMENT

One of the major functions in any Presentation Manager application is manipulating windows on the screen. The window management group is the largest set of API services, providing facilities for creating, sizing, moving, and otherwise controlling windows as well as their contents.

Each window must belong to a *window class*, either one of the predefined ones (see table 1) or a customized class the application creates. Associated with each class is a window procedure that receives and processes messages for any window of that class and a base set of attributes, called *class styles*. The available class styles and the named constant identifying each are listed in table 2. Class styles cannot be changed during the window's life.

Each window is a member of a window class with the procedure and class styles of that class. In addition, the application can assign a set of individual window styles to each window (see table 3). Unlike class styles, which are permanent, individual styles may be changed during the window's lifetime. As each window is created, the system assigns it a unique handle that the application uses to identify the window in subsequent API calls.

A large set of window management routines is available for querying and adjusting the attributes of windows. Besides the window-style attributes listed in table 3, several global attributes can be assigned to a window. The *active* window is the one that is "on top" of the stack of displayed overlapping windows. The *focus* window receives all keyboard input, while the *capture* window receives all mouse input, wherever the mouse cursor is. In the absence of a capture window (the usual situation), mouse input is directed to the window containing the mouse cursor, provided that window is enabled. The *system modal* window can override every other window and will receive all mouse and keyboard input. This window is commonly used to request user response to critical error situations.

Each window has an input queue that receives the messages resulting from user and program actions that affect the window. For example, clicking a mouse while the cursor is within a window generates a message. Messages are also created when windows are created or destroyed, or when their status is switched between active and inactive or visible and hidden. The system performs the actual creating, destroying, or status switching, not the window procedure. But the window procedure gets an opportunity to execute application-specific initialization or termination code.

Note that the application never directly calls the window procedure to manipulate its windows. Instead, it calls an API function that issues the appropriate message. The reason for this indirect approach is to separate any of the actual display interactions from the application. Because each window has to share a display with other windows, some of which belong to other applications, a window can receive orders from many sources, not just the application that owns it. The message queue receives window procedure messages from any sources equally well and asynchronously. Application code does not have to coordinate window updates with other applications, for this common code is part of the Presentation Manager. But the compromise that makes it all work is that the application is barred from directly addressing even its own windows.

An application that creates more than one window can arrange them in a hierarchical structure of parent and child windows. At the top of this structure is the *desktop window* (all of the display screen) owned by the Presentation Manager. The main windows applications create are called *top-level windows*; they are arranged in overlapping fashion within the desktop window. Applications can create multiple top-level windows, or *child windows,* which are in turn arranged in overlapping fashion and totally contained within their parent windows. The depth of this structure has no inherent limitation, but in practice it is limited by the size of the physical display screen.

The motive for nested windows is that programming is easier when windows only contain one data item or one data type. When a window displays output only, then it is not difficult to put different objects into it. The situation is much more complex when the window must interact with the user. When a window represents more than one kind of data, the program must know more about the context surrounding an interaction.

TABLE 3: ***Individual Window Styles***

STYLE NAME	DESCRIPTION
WS_VISIBLE	Window is visible
WS_DISABLED	Window is disabled (does not respond to mouse)
WS_CLIPCHILDREN	Clips output to prevent overlaying child windows
WS_CLIPSIBLINGS	Clips output to prevent overlaying sibling windows
WS_GROUP	Marks a collection of dialog items as a group
WS_TABSTOP	Marks dialog item as a tab cursor stop
WS_SYSMODAL	Window does not relinquish control until finished
WS_MOVENOTIFY	Window generates WM_MOVE message when nudged

An individual window can be created with any combination of these styles added to the class style. Attributes defined by individual styles are applied when the window is created, but subsequently may be changed by the program.

For example, if a window that displays both text and a pie chart receives a message indicating a mouse click, how should the program react? It would have to know the kind of object underneath the mouse cursor before it can decide whether to display an edit bar in a line of text or highlight a sector of the pie chart. And what should the program do if the pie chart overlapped the text data at the mouse cursor position? Using a hierarchy of windows, each containing one type of item, removes from the application the burden of arbitrating which of several overlapping coordinate systems is the target of user interactions.

In addition to the parent-child relationship of the window hierarchy, there is another relationship that can be established between two windows. When a window is created, an *owner window* may be specified for it. The owner need not be the parent, but it can be any existing window of the hierarchy. An owned window can easily send messages to its owner; furthermore, it becomes hidden or deleted if its owner is hidden or deleted.

One use for owned windows would be for a parent window to get a message concerning some user interaction that affects one or more of its child windows. For example, the parent window might create an owned interaction window (which may or may not also be its child) as a control panel for specifying how to manipulate data displayed in the child windows. A mouse-pick in the control would cause that window procedure to notify its owner window of the selection; the parent window can then relay the appropriate messages to the window procedures of the child windows.

All displayable windows belong to the hierarchical structure that has the desktop window at its peak. But an application can also create windows that have no parent and are not part of this hierarchy. Such windows, called *object* or *orphan* windows, cannot be made visible, but do have a window procedure that can process messages. They are handy for doing internal message-based processing in situations that do not need display space. Object windows can have owners (either object or normal windows) and can be converted to and from normal windows with the API function WinSetParent.

The Presentation Manager API provides a comprehensive set of services for creating and managing a hierarchy of windows, making it convenient to simplify each window's contents. It includes functions for traversing a window hierarchy. Given a window, functions can determine its parent; first, last, next, or previous child; all of its children; and its owner.

Window management includes functions supporting *dialog boxes* and *controls*, which are specialized windows designed for the sole purpose of accepting user input. A dialog box typically contains several items for the user to fill in or select with the mouse or "point-and-shoot" keyboard control. A dialog box that disallows interacting with other windows while it is visible is called *modal*, and one that does not is called *modeless*.

Because of its specialized usage, the API for dialog boxes differs from that for normal windows. Dialog boxes come in three styles, specifying the type of frame to use for the box, whether to place the box in a fixed position on the screen, or whether the position is relative to the current position of the mouse cursor. Messages generated by dialog box interactions,

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System Requirements: IBM PS/2 model 50 or 60 with IBM PS/2 80286 Memory Expansion Option board or compatible. Note: IBM PS/2 architecture requires disabling motherboard memory and 'backfilling' conventional memory to 1 MB in order for any multitasking environment to work, including Microsoft Windows 2.0, IBM's 3270 workstation program, or DESQview. QEMM will not run on 80286 computers with extended memory.

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although similar in content to the corresponding ones from normal windows, have different message IDs.

The API supports a number of predefined control windows that applications can use, typically as elements within dialog boxes. Each has a predefined shape and function and generates an input message when selected or otherwise nudged by the user. The major types of controls are as follows.

- *Push-buttons* are small windows, each containing a single short entry, that can be selected by moving the mouse cursor or highlight and clicking a mouse button or pressing the Enter key. When combined in groups with a procedure that allows only one at time to be selected, they are called *radio buttons*.
- *Edit controls* show one line of text to be entered or edited by the user. The edit control with the focus shows a blinking cursor and permits all the standard editing options: delete/ insert and cut/copy to/from the clipboard. Initially, a 32-character buffer is associated with an edit control, but the program can change this size.
- *Scrollbars* are narrow horizontal or vertical windows in which the user can specify how to scroll the information in another window. Unlike most other controls that can be used with either the keyboard or mouse, only the mouse can use scrollbars. They can be placed anywhere in an owner window, and their number has no inherent limit, but the recommended standard user interface calls for one each in the bottom and right-hand frame of a window.
- *Listbox controls* are used to contain a list of items, each a string of several characters and each individually selectable. The list can be set up to allow one or several items to be selected in one interaction. Each item can be associated with some data other than the displayed string—for example, the binary form of a number displayed in character form. If the number of items is larger than can be displayed at once, a scrollbar can be incorporated into the frame of the listbox. A typical use for a listbox would be to select one or more files from a directory.
- *Menus* are windows containing a list of commands that are selected either by a mouse-click or by typing a character. They are of two types: horizontal menus, also called *action bars*, typically used for the top-level menu in a window; and vertical menus, usually of the pop-up or drop-down variety invoked from a higher-level menu. Besides functions for initially defining menus, the API also provides services for dynamically expanding or contracting the menu list. The menu window automatically expands or shrinks with no effort on the part of the application.

The character keys used to select a menu item (in lieu of pointing to it with the mouse cursor or keyboard-controlled highlight) are called *mnemonic keys* and are specified by the application when it builds a menu. A mnemonic key need not be the first character of a menu entry, but must be one of the characters in the menu text so that it can be highlighted when the menu is displayed.

Menu items can also be associated with *accelerator keys* that, like mnemonic keys, are short-cuts to selection.

> ***One of the distinguishing features of the Presentation Manager is that all input is asynchronous—the system can handle it at any time.***

Whereas mnemonic keys cannot be used until the desired menu is displayed, accelerator keys can invoke a selection without traversing several levels of menu structure or even displaying the topmost level. For example, a function key can be used to directly invoke a program function that otherwise might involve selecting from an action bar, then a second-level menu, then a third-level menu. Mnemonic keys could be used at each level, but the accelerator can cut through all levels with one keystroke.

An application can define two kinds of tables of accelerator keys. A local table applies to an individual window; the keys it defines are active only when that particular window has the keyboard focus. A global table defines keys that are active from anywhere in the application, no matter what is on screen at the moment.

The API's extensive support of control windows would encourage building applications with a consistent user interface, because a developer will find it more convenient to use the standard facilities provided instead of devising yet another command structure.

HANDLING INPUT

The API handles input from all possible sources: keyboard, mouse, system messages, communications between programs, and timer events. One of the distinguishing features of the Presentation Manager is that all input is potentially asynchronous—that is, not limited to the times when a program requests it and is prepared to accept it. Therefore, the system handles all input, determines the window that is to receive it, and places an input message into that window's input queue. Each window has one input queue, but one queue can handle messages for more than one window. Each message contains the handle of the intended recipient window. Messages can result not only from user input events, but also from program-generated events such as inter-process communications and timer interrupts.

An application reads the messages from the queue and passes each of them to the appropriate window procedure. If the application decides not to process a message, it can pass it to a system default procedure that performs a predefined process for each type of message. Alternatively, the application can simply discard the message.

Although normally a queue is a first-in, first-out structure, the application does have some control over the sequence in which it processes the messages. It can limit the messages that it will accept to a specific range of message types, or to only those for a particular window and its children. The messages that do not meet these criteria remain in the queue for processing at a later time.

HANDLING OUTPUT

To create output, Presentation Manager applications use two types of internal objects, *device contexts* and *presentation spaces*. A device context contains low-level information about a particular physical device, as well as the code for sending data to it and otherwise controlling it. It is the Presentation Manager's equivalent of an OS/2 device driver. A presentation space represents the surface on which the output is produced and is independent of any hardware characteristics.

Normally, an application creates a presentation space, associates it with a device context, and then sends output to the presentation space, not directly to the device. The same presentation space may be later reassociated with a different device context to recreate the same output on a different medium.

The API supports five types of output devices: the screen, memory bitmaps, metafiles (bitmaps on disk), queued devices, and direct devices. The last two are typically printers and plotters, with and without spoolers. A sixth "dummy" type, the *info* device, can be associated with any physical device for the purpose of obtaining information about its capabilities without actually sending it any output. Note that writing nongraphics data to disk files is performed via the API of OS/2, not the Presentation Manager.

The API for device contexts is quite small (eight functions), because applications typically do not deal with devices on such a low level. Most frequently used are the functions to open and close the device and to determine its capabilities. Several functions also allow an application to send output directly to the device and otherwise communicate with it on a low level, thus accommodating devices whose capabilities are not supported by the available software drivers. This, however, has a price: the program loses the device independence that is one of the design goals of the Presentation Manager.

The API makes a fundamental distinction between alphanumeric and graphics output. Graphics output is contained within a graphics presentation space whose coordinates are finely divisible. On the other hand, alphanumeric output is written (with calls to the VIO library functions) to an alphanumeric presentation space in which all the possible display positions form a coarser grid corresponding to the dimensions of the character cell of the output device. For both graphics and alphanumeric output, however, the application need not concern itself with the actual resolution or display size of the device. The API functions for dealing with graphics presentation spaces are an inseparable part of the GPI.

The output handling of the Presentation Manager is *modal*, meaning that the effect of a call to an output function depends not only on the parameter values passed in that call but also on certain attributes or modes set by one or more previous function calls. These modes are applied to a presentation space; therefore, an application can operate in multiple modes by opening several presentation spaces. The modal attributes include such factors as whether output is drawn immediately or stored for later use, line and arc styles (solid, dotted, dashed, etc.), area fill patterns, symbol sets and font styles, and color palettes.

When a presentation space is created, it takes on a default set of attributes. The application cannot specify which attributes a presentation space should have when created, but it can change the attributes after creating the space. This could be both inconvenient and inefficient for applications that create many presentation spaces with similar but nonstandard attributes.

One of the major modes that can be set for a presentation space is when the output drawn on it is sent to the device. On micros, display output has usually been drawn directly to the screen using bit-mapped video memory, but another method (common on CAD workstations) involves drawing an image offscreen first. When an image is stored in memory, a program can keep the image for later use and then display the completed image—quickly. Drawing a complicated image sometimes takes a considerable amount of time, and users must wait as a diagram is reconstructed pixel by pixel. Creating images offscreen is more efficient, allowing the user in the meantime to inspect whatever is already finished and onscreen.

In the Presentation Manager, the application can choose to draw output immediately, store it for later use, or

both. The three modes are called, respectively, *store mode, draw mode,* and *store-and-draw mode.* Stored output is kept in a graphics segment. Any number of graphics segments can be created for each presentation space; however, in keeping with the modal nature of presentation spaces, only one graphics segment can be open to receive output at a time. In addition to modularizing graphics for rapid assembly into complete displays, segments can make window updates—caused, for example, by changing the window size—tantalizingly fast.

ARTISTIC SERVICES

The GPI library provides the services for drawing the Presentation Manager's impressive graphics. The system uses these routines internally, as do applications; for example, to draw a window frame, the window management routines call GPI routines to draw the lines, fill in the colors, and draw the characters. Within the GPI are functions for drawing graphics primitives such as arcs and lines; manipulating bitmaps, regions, images, and textual symbols; and generally controlling the graphics environment by setting video attributes, mapping, and transforming coordinate spaces within display segments.

The Presentation Manager GPI provides many of the same graphics primitives and other constructs as Windows does, but the Windows GPI is lean whereas the new one is stout and comprehensive. Historically, the new GPI descends from the Graphics Display Data Manager (GDDM) standards developed at IBM a decade ago for mainframe use, and the Microsoft Windows Graphics Device Interface (GDI).

The GPI provides the API functions for creating and controlling presentation spaces and producing graphics output. The number of functions in this library is almost as great as that in the windows management library, and their complexity is greater.

A graphics presentation space represents a flat plane with finite extent; its size is specified at creation in the application's choice of units: inches, millimeters, pixels, twips ($\frac{1}{20}$ of a printer's point, or $\frac{1}{1,440}$ inch), or arbitrary units not related to any physical measure. The coordinate origin is at the lower left corner of the space, with x-axis values increasing to the right and y-axis values upward. Both the overall dimensions of the space and coordinates within it are specified as long signed integers, resulting in an inherent resolution limit of 1 in 2^{31}.

The application can work with graphics in several coordinate spaces; API provides functions to transform coordinates from one space to another:

- The *world coordinate space* is created with the presentation space; the units can be whatever is convenient for the application to deal with.
- The *model space* is used to map several objects from world space into one picture. For example, when drawing an automobile, each of the four wheels is the result of mapping a single world space into different locations in the model space.
- The *page space* defines the limits of what appears in a single picture. For example, the complete automobile might be mapped into a page space containing images of other vehicles. The entire page space need not be visible at one time, but may be scrolled under a window.
- The *device space* is defined in terms of the physical units of the device—for example, pixels on a display. Eventually, all graphics must be mapped into device space, but usually this is transparent to the application. However, the application can, if it should desire, transform coordinates into this space and deal directly with the device.

TABLE 4: ***GPI Graphics Primitives***

FUNCTION NAME	DESCRIPTION
GpiMove	Moves current point without drawing
GpiLine	Draws a line from current point to specified point
GpiPolyLine	Draws straight lines connecting a series of points
GpiBox	Draws a rectangle defined by current point and diagonally opposite corner
GpiArc	Draws elliptical or circular arc through three points
GpiFullArc	Draws an ellipse or circle around current point
GpiPartialArc	Draws a ray and a section of arc (a sector with one side missing)
GpiPolyFillet	Draws a curve that smooths out a polyline through a series of points
GpiPolyFilletSharp	As in GpiPolyFillet, but the curvature of the fillet can be specified
GpiPolySpline	Draws a succession of Bezier splines through a series of points
GpiCharString	Draws character string beginning at current point
GpiCharStringAt	Draws character string beginning at a specified point
GpiCharStringPos	Draws character string, using an array of inter-character spacings, beginning at current point
GpiCharStringPosAt	As in GpiCharStringPos, but begins at a specified point
GpiMarker	Draws a marker character at a specified point
GpiPolyMarker	Draws a marker at each of a series of points
GpiImage	Sets pixels from a bit-map array
GpiSetPel	Sets a pixel at a specified point to the current color

The graphics primitives may be sequentially combined to produce output of arbitrary complexity. The graphics model is a modal one; most functions start drawing from a current point and use attributes set by previous functions.

The API functions that actually produce graphic output to a presentation space are listed in table 4. Besides the fairly common line, arc, and box functions, others draw more complex curves such as fillets and splines.

Markers are used similarly to colored thumbtacks on a bulletin board. They are often used repetitively, forming curves or lines across a window. The base marker set includes such symbols as a cross, dagger, diamond, square, six-pointed star, eight-pointed star, solid diamond, solid square, dot, small circle, and the blank.

Area functions are supported in a very flexible fashion. After a call to GpiBeginArea, all subsequent line and arc primitives define the outline of an area. Then, a call to GpiEndArea automatically draws the last straight line to close the area, if necessary, and fills the area with the current fill pattern. This procedure allows arbitrarily complex areas to be created.

The underlying graphics model of the GPI is the *current point* model, in which every function producing graphics output starts from the point the previous function reaches. This is an extension of the modal nature of Presentation Manager graphics. In a modeless system, a program could specify what it wants done in a single function call—for example, draw a solid red line from point *a* to point *b*. Using the GPI, however, the program needs to issue three calls: set the current line style to solid red; move the current point to *a;* draw a line to *b*. Note that setting the current point before calling the line-drawing function is similar to setting one more modal attribute; the difference is that most drawing functions change the current point (in this example, it winds up at *b*), but true modes remain set until explicitly changed.

The modality of the GPI seems at times rather excessive; for example, the radius and aspect ratio of an ellipse or circle are specified not as arguments to the arc-drawing primitives but by setting attributes via a call to the function GpiSetArcParams. None of the drawing primitives is self-sufficient; each requires that several attributes be set before it is called.

Furthermore, attributes proliferate; for example, there are separate color attributes for line/arc functions, character functions, marker functions, the GpiImage function, and area fill functions. The GPI also supports the use of a logical color table, which translates the colors the application thinks are being used into actual colors seen on the output device. The default table supports only eight colors, but device contexts for specific devices (the EGA, for example) can load larger tables.

The GPI functions used for setting attributes are listed in table 5. Attributes can be set individually by calls to specific functions like GpiSetLineWidth, or in groups by calling GpiSetAttr. The latter sets all of the attributes for a particular class of graphics primitives—for example, line-drawing functions. Certain attributes, such as the line-drawing color, can be set only by GpiSetAttr, not individually; GpiSetColor sets the foreground color for all graphics and text primitives.

One attribute controls how other attributes are handled when they are changed. A call to GpiSetAttrMode can set the *push mode*; then the current state of an attribute is saved on a stack whenever that attribute is changed. The previous value can be restored by calling the function GpiPop. In addition, the GPI has functions for explicitly saving and restoring individual attributes. These use a stack separate from the one used by the implicit push mode.

Clipping. A clipping area is a subregion of a presentation space outside of which graphics output is made invisible. Once an application defines a clipping area, it can draw into the entire presentation space, and the system ensures that no output is produced outside the clipping area. A rectangular clipping area, the most usual kind, can be defined by a single API call. But the GPI also allows the definition of arbitrarily complex clipping areas, using the same mechanism as for area fills: a series of line and arc primitives bracketed by calls to GpiBeginClipArea and GpiEndClipArea.

Even when no clipping area is defined, clipping is automatically performed when the presentation space extends beyond the boundaries of a window; the boundaries of child windows, in turn, are clipped to remain within their parent windows. Although clipping is automatic and transparent, the application can improve system performance by minimizing graphics output to areas known to be invisible.

Regions. Another way to control clipping is by defining a region, which is a portion of the presentation space defined by a set of rectangles. These rectangles need not be adjacent, so the region may have holes in it. The GPI provides functions that define and modify the extent of a region, establish

TABLE 5: *GPI Attribute-setting Functions*

FUNCTION NAME	DESCRIPTION
GpiSetAttrMode	Controls whether current settings are saved when attributes are changed
GpiPop	Restores the most recent attribute setting when the save mode, as established by GpiSetAttrMode, is in effect
GpiSetAttrs	Sets specified attributes for specified graphics primitives
GpiSetColor	Sets foreground color for all graphics primitives
GpiSetBackColor	Sets background color for all graphics primitives (may be set to transparent)
GpiSetLineType	Sets the line type to solid, dotted, dashed, etc.
GpiSetLineWidth	Sets "cosmetic" line width; this width does not vary when window is zoomed
LineWidthGeom	Sets "geometric" line width which is scaled when window is zoomed
GpiSetArcParams	Sets direction, radius, and aspect ratio for elliptical and circular arcs
GpiSetPatternSet	Establishes a set of characters from which to choose an area fill character
GpiSetPattern	Chooses an area fill character from the set established by GpiSetPatternSet
GpiSetCharSet	Chooses a character set for text output
GpiSetCharBox	Sets the dimensions of the character cell
GpiSetCharAngle	Sets the baseline angle for character output
GpiSetCharShear	Sets the angle of characters with the baseline
GpiSetCharDirection	Sets the direction of character output (left-to-right, top-to-bottom, etc.)
GpiSetCharSpacing	Scales inter-character spacing
GpiSetCharExtra	Varies inter-character spacing by adding or subtracting a fixed amount of space
GpiSetMarkerSet	Establishes a set of marker characters
GpiSetMarker	Chooses a marker character from the set established by GpiSetMarkerSet
GpiSetMarkerBox	Sets the character cell size for markers

The graphics primitives listed in table 4 use attributes previously set by these functions. For example, drawing a circle requires setting the radius and aspect ratio with GpiSetArcParams, then actually drawing it with GpiFullArc.

it as a clip area, determine whether a specified point or rectangle are within the region, and find the tightest rectangle that contains it. Besides defining a clip area, a region can be used to draw an irregular rectilinear image.

Bitmaps. As mentioned previously, one type of device context that can receive the output of a presentation space is system memory. The result is a bitmap, a rectangular object containing the bit-by-bit representation of all the graphics output into that presentation space. Bitmaps can also be saved into and loaded from metafiles.

In the GPI, the standard organization of a multibit bitmap is nonplanar, where all the bits in a pixel are physically adjacent in RAM. This organization is at odds with the hardware of many display devices, particularly those that handle 24 bits worth of color information; these devices arrange the bits of a pixel in separate bit planes. They require converting GPI-standard bitmaps to a hardware-compatible planar format just before display.

The GPI provides a number of bitmap operations (also variously called raster operations, rasterops, and bitblt operations), for establishing, modifying and copying the contents of bitmaps. These operations can enhance the user interface—for example, by moving static graphics rapidly around the display, or redisplaying the part of a window that used to be covered by another window. The GPI can handle bitmaps with either one bit per pixel (for monochrome graphics), or more than one bit per pixel (for gray scales or multicolor graphics).

The most useful operation involves copying bitmaps from one presentation space to another with the GpiBitBlt function. This operation involves three components: the source rectangle, the destination rectangle, and a rectangle of pattern data.

The source and destination rectangles do not have to match in size or shape. The dimensions of one rectangle can be scaled to match the corresponding dimension of the other or simply to clip any source data that falls outside the destination.

Options can combine the source, destination, and pattern data to produce a new bitmap at the destination—for example, OR the source into the destination, then AND the pattern. The effect of these options is almost limitless flexibility in transforming the bitmap into another image.

Metafiles. The Presentation Manager includes support for interchanging graphics data such that graphics generated on one system can be drawn as faithfully as possible on different systems. A metafile is a record of a stream of graphics commands sent to the Presentation Manager; the metafile can be played back through the Presentation Manager, but using different device contexts and presentation spaces (within functional reason; it is tedious, but not impossible, to get plotters and daisy wheel printers to react properly to bitmap operations). Metafiles contain as much as possible about the description of an image, including clip and area fill instructions.

A metafile is created by opening it as a device context, associating it with a presentation space, and then drawing into the space. The draw commands, instead of producing visible output, are stored on disk. Subsequently, when the metafile is read into another presentation space, it will produce output on whatever device context is associated with the new space.

Developers beginning to probe the intricacies of Presentation Manager could easily be overwhelmed by the length and breadth of services provided. But despite its complexity, the benefits could be just as overwhelming. Software users—and buyers—appreciate having an interface consistent among all their programs. And they appreciate menus and windows. The Presentation Manager has charted the course to fulfill these desires. Programming for it could be easier than charting your own course.

Michael Brian Bentley is director of computer services for G-Bar Corporation in Chicago. He is the author of The Viewport Technician: A Guide to Portable Software Design *(Scott, Foresman and Company, 1987).*

COMPUTER SYSTEMS

386

COMPATIBILITY

PERFORMANCE

If it's power you want, the Compaq Deskpro 386/20 is a likely candidate. Its Flex architecture is the first to use the Intel 82385 cache controller, providing the fastest memory operations seen in a desktop.

Full Speed Ahead

DAVID CLAIBORNE

Compaq wants to be the Cray of the microcomputer industry. The Cray supercomputer, in its various forms, is generally acknowledged to be the fastest, most powerful computer available today. Its processing capability and speed are so much greater than anything else available that Cray does not worry about price competition. If you need the processing power of a Cray, you buy a Cray—that is, if your budget is big enough. Cray does not compete on cost, it competes on power. Cray brings out more powerful computers, not cheaper ones.

With the introduction of its newest computer, the Deskpro 386/20, Compaq continues to follow the Cray example. It wants to develop and sell the microcomputer for the program developer who wants programs to recompile in seconds instead of minutes, the CAD user who wants screens to appear instantly instead of line by line, and the accountant who want his national budget spreadsheet to recalculate between coffee sips, not coffee cups. Compaq wants to provide computer power in a desktop package that is unavailable anywhere else.

Compaq, which started as a manufacturer of IBM compatibles, continued to follow IBM's technological lead with the introduction of its Deskpro series. The Deskpro line offered many innovations, such as the first internal backup tape drive, but they were still considered to be IBM clones.

In late 1986, Compaq ceased to follow and started to lead. It introduced the Deskpro 386, one of the first microcomputers to use the Intel 80386 microprocessor. Then, in September 1987, Compaq introduced the even faster and more powerful Deskpro 386/20. This machine, based on the 20-MHz version of the 386, uses innovative design and state-of-the-art components and peripherals to realize more computer power than previously available from any desktop microcomputer.

With the Deskpro 386/20, Compaq is reaffirming its claim to the most powerful and technologically advanced microcomputer available. The Deskpro 386/20 continues Compaq's commitment to compatibility with the hardware standards set by IBM. Compaq continues to charge the full price for its innovation and quality.

From the outside, the Deskpro 386/20 is identical to the other computers is the Deskpro family (see photo 1). The only difference is the name plate. But the Deskpro 386/20 *is* different. Its processing capability exceeds that of many minicomputers made today. The speed is immediately evident when the machine is turned on—it flies through the memory check at a megabyte every second and a half. DIR screens scroll by so fast they cannot be read. Programs that normally load in a few seconds snap on the screen instantly. Microsoft Windows finally has a processor that can keep up with it and make it a useful system.

The Deskpro 386/20 has more than just a fast clock rate. The system memory uses a 32KB cache of 35-nanosecond (ns) memory controlled by a dedicated processor, the Intel 82385, to provide memory operations faster than anything previously available. The disk drives, up to 300MB in size, are all exceptionally fast and accessed via a 16-bit bus. The numeric computational speed obtained with the optional Weitek coprocessor ($1,999) rivals that of many mainframes.

PHOTOGRAPHY • MARC DAVID COHEN

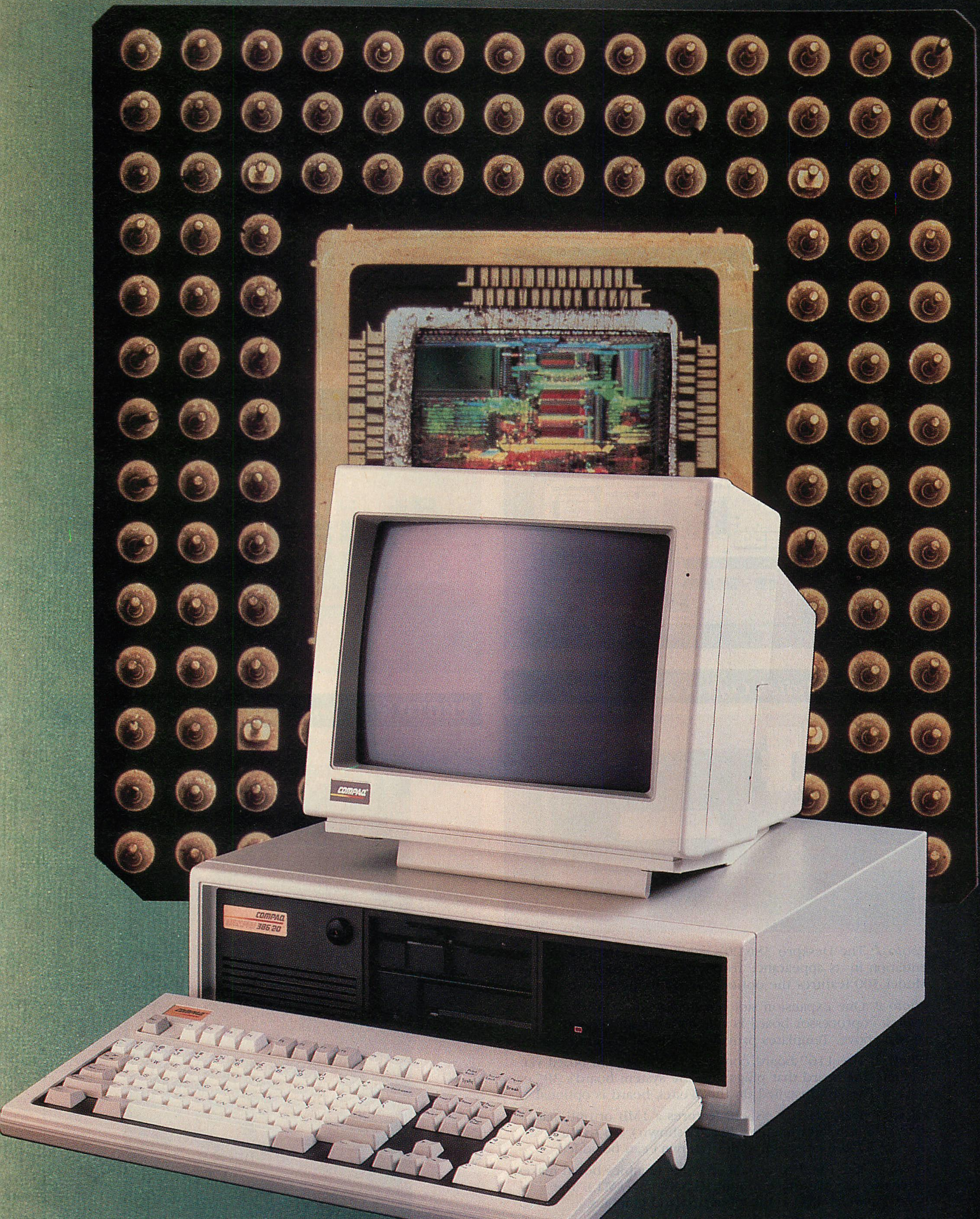

COMPAQ
COMPAQ
386/20

PHOTO 1: ***System Unit***

PHOTO 2: ***Inside the System Unit***

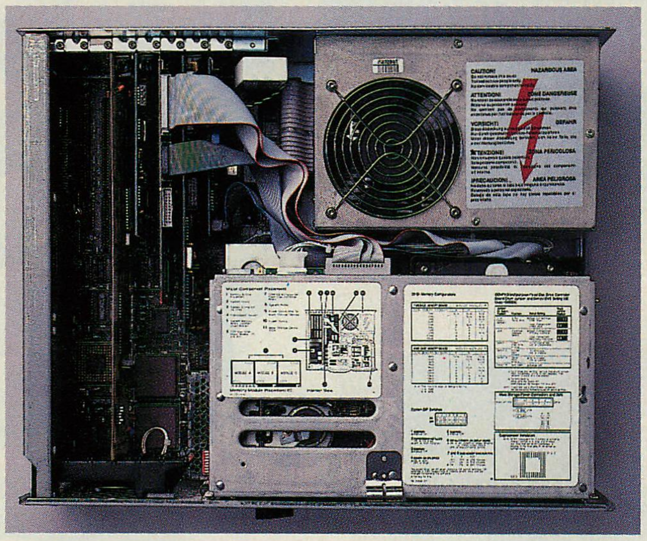


PHOTO 3: ***Weitek Coprocessor Board***

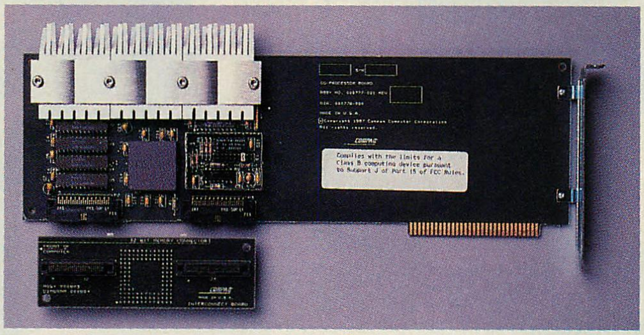


Photo 1: The Deskpro 386/20's nameplate is the lone differentiation in its appearance from other Deskpro models. This Model 300 features the optional 135MB tape backup unit.

Photo 2: One expansion slot remains available when the Weitek coprocessor board is added to the Model 300 shown above. Templates provide configuration information.

Photo 3: The 1167 board connects to the system board via a connector board that plugs into the system board's 387 socket. The 387 installed on the Weitek board is optional.

Photo 4: The Deskpro 386/20 features a 1MB or optional 4MB 32-bit system memory board (shown). Up to three 4MB or 1MB memory modules (shown) can be added.

Photo 5: The Compaq enhanced color graphics board makes extensive use of surface mount technology (SMT). The board provides EGA-compatible text and graphics.

Photo 6: The 20-MHz 386 is mounted bottom center, with the 82385 cache controller just above; the system's 32KB SRAM cache is to the right, the 387 socket to the left.

PHOTO 4: ***System Memory Board***

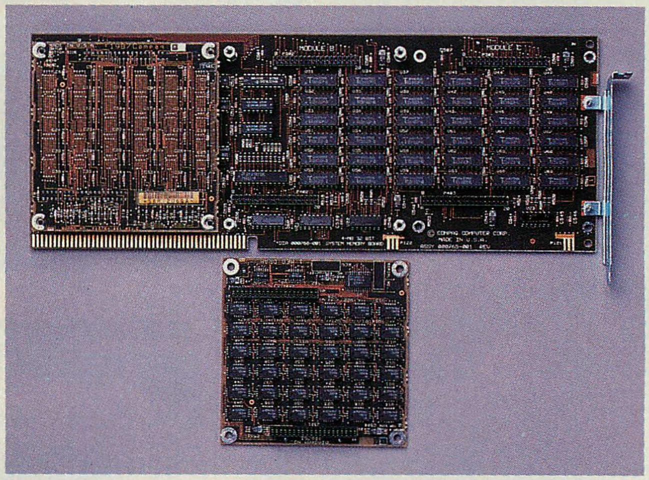


PHOTO 5: ***EGA Board***

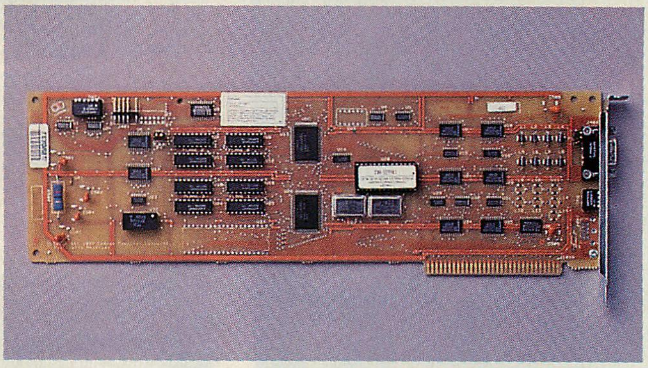
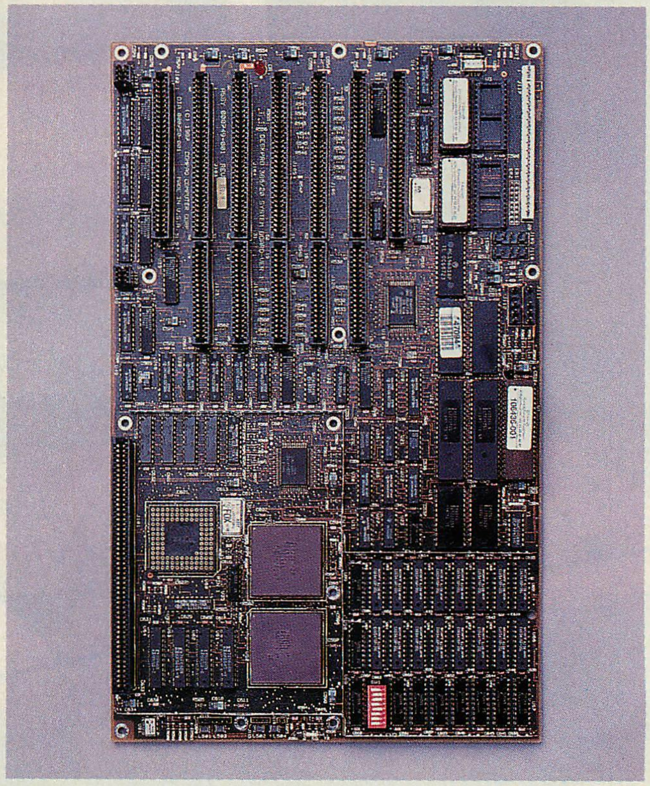


PHOTO 6: ***System Board***



The cost of all this speed and performance is appropriate for its value. But remember, Compaq wants to compete on technology, not price. The base unit, with 1MB of memory and a 60MB hard disk, and few necessary options (Compaq monochrome controller and display and MS-DOS) totals to just over $8,000. When more options, like extra memory, coprocessor, larger disk drive, and EGA monitor, are added, the price gets very high, very fast. The fully configured evaluation unit lists for $23,458. (The prices for the base units and the available options are shown in the sidebar, "Deskpro 386/20 Vital Statistics." Options included with the evaluation unit are marked with an asterisk).

NEW AND IMPROVED

The Deskpro 386/20 contains several innovations not seen before in a personal computer. Most notable are the memory cache system, the powerful Weitek coprocessor, the larger, faster tape backup drive, and the larger, faster hard-disk drives.

Memory cache system. Compaq has chosen to incorporate a memory cache system to provide memory operations at the same pace of the 20-MHz processor without incurring the cost of large amounts of fast memory. The memory cache system is based on the new Intel 82385 cache controller. The 82385, a very large scale integration (VLSI) device, allows the intelligent, efficient use of a 32KB cache of 35-ns static RAM. (See "Memory in the Hot Seat," Steven Armbrust and Ted Forgeron, February 1988, p. 84.)

Compaq calls this configuration its Flexible Advanced Systems (Flex) architecture. This architecture provides the 20-MHz 386 CPU with high-speed access to the contents of system memory via the cache, independent of memory accesses from devices on the standard 8-MHz AT-type system bus (see figure 1). CPU read requests for data contained in the cache occur with zero wait states inserted. Requests for items not stored in the cache occur with four wait states inserted. Writes to memory are buffered and can occur at zero wait states if the previous CPU-initiated write to memory has completed.

The 82385 cache controller monitors access to memory by other system devices, in order to maintain the integrity of the data stored in the cache. If a device changes the contents of a memory locations stored in the cache, the 82385 marks the cache entry invalid, so that it will be read from memory when next requested by the 80386.

Compaq claims that 90 percent of CPU memory accesses are for data stored in the cache. The effect of the cache can be seen by running Norton's System Information (SI) test several times in succession. Running the test once produces an SI value of 29.4. Subsequent runs (during which the number of cache hits are higher) produce an SI value of 31.6.

Weitek coprocessor board. Weitek Corporation has been making dedicated math coprocessors for minicomputers and super microcomputers, such as Sun, Apollo, Convergent, since 1981. Unlike Intel's single-chip 80387 math coprocessor, Weitek's 1167 board integrates three custom Weitek chips to form a powerful computational engine. The board combines Weitek's multiplier chip (1164) and arithmetic logic unit (1165) with a chip developed by Weitek and Intel to integrate the other two chips with the 386 (1163). Weitek tests indicate that the 386/1167 combination is three to four times faster than the 386/387 combination.

The potential for a Weitek-equipped Deskpro 386/20 is tremendous. In CAD applications, linear programming, and other numeric-intensive operations, the speed of the 386/1167 combination should rival that of any minicomputer. The problem is that very few microcomputer applications currently are use the Weitek.

Several companies are producing compilers that allow existing applications to be recompiled with the Weitek calls. Both Green Hills Software Inc. and Silicon Valley Software Inc. have C, FORTRAN, and Pascal compilers that contain software support for the Weitek 1167 board. Santa Cruz Operation Inc. (SCO), makers of XENIX 386 System V, has announced plans to provide support for the 1167 in 1988.

Tape backup drive. The 135MB tape backup drive is a new product for Compaq, and it comes with a new tape operating system called SYTOS. The drive uses the larger DC600 tape cartridge. The published file transfer rate for the tape drive is 5MB per minute, versus 1MB per minute for the 40MB device. The evaluation unit came close to this rate, transferring files at 4.5MB per minute as it backed up almost 30MB. The efficiency of the data transfer goes down as the amount of data transferred is reduced. Unlike the 40MB tape drive with the DC2000 cartridges, the tape does not have to be formatted before it can be used.

SYTOS, developed by Sytron, a company in Marlboro, Massachusetts, is a complete operating system for the tape drive. It is an extremely complete command system for using a tape backup system. Both backup and restore functions can be performed using a Lotus-like menu scheme. SYTOS keeps a directory on the tape for selective restoration of files. The regular Compaq TAPE utility does not work with the 135MB tape drive.

DESKPRO 386/20 VITAL STATISTICS

Model 60: $7,499
1MB memory
32KB SRAM cache
Serial and parallel interfaces
Realtime clock
1.2MB diskette drive
Enhanced keyboard
80387 socket
60MB hard disk

Model 130: $9,499
All features of Model 60 except
100MB hard disk with ESDI controller

***Model 300: $12,499**
All features of Model 60 except
300MB hard disk with ESDI controller

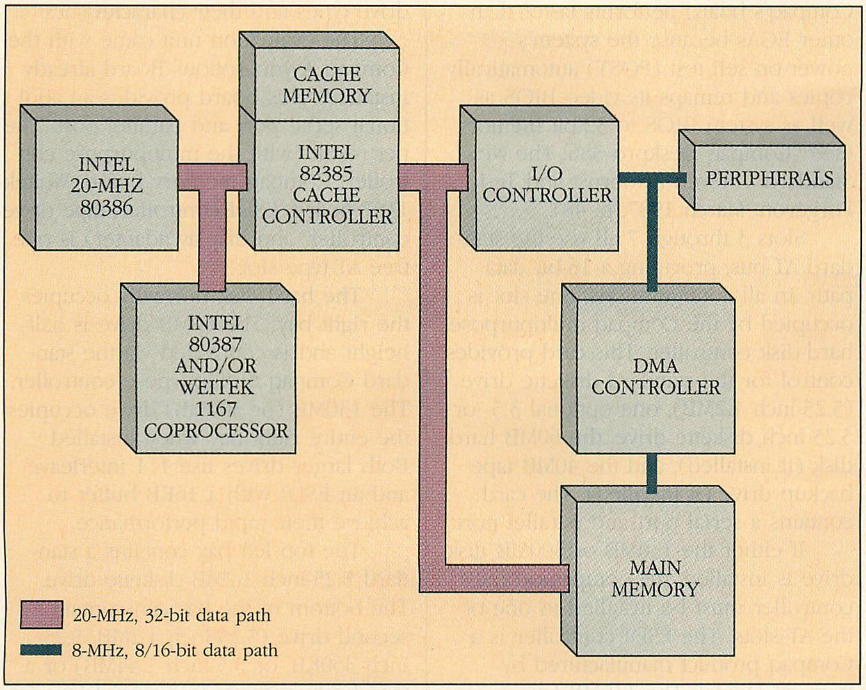
Internal memory capacity:
13MB (16MB using 4MB system memory board)

Available slots (in expansion unit):
8/16-bit: 4 (3 in Models 130, 300)
8-bit: 2

Available options:
5.25-inch 360KB diskette drive: $225
3.5-inch 1.44MB diskette drive: $245
5.25-inch 1.2MB diskette drive: $275
40MB tape backup drive: $799
*135MB tape backup drive: $1,999
*80387 coprocessor (20 MHz): $1,199
*Weitek coprocessor board: $1,999
*Compaq Asynchronous Board (serial port, parallel port): $149
*Compaq Color Monitor: $799
*Compaq Enhanced Color Graphics Board: $399
Compaq Dual-mode Monitor: $255
Compaq Video Display Controller Board: $199
*1MB 32-bit memory module: $549
4MB 32-bit memory module: $2,049
*4MB system memory board: $2,999
*MS-DOS/BASIC 3.3: $120
**Technical Reference Guide*: $149
**Compaq Enhanced Color Graphics Board/Compaq Color Monitor Technical Reference Guide*: $49

An asterisk (*) indicates the model reviewed and the options included. The announced retail price of that model with those options is $23,458.

FIGURE 1: *Flex Architecture*



The Deskpro 386/20's Flex architecture allows the 386 processor, its coprocessors, and the cached memory subsystem to communicate over a high-speed, 20-MHz bus, while I/O devices are accessed using a standard 8-MHz AT-type bus.

Hard-disk drives. Compaq is offering 130MB and 300MB hard-disk drives as options with the Deskpro 386/20. The drives use an enhanced small device interface (ESDI) controller to achieve average access times of less than 20 milliseconds. The Compaq version of MS-DOS 3.3 allows disk drive volumes up to 512MB, further enhancing the value of these larger drives.

SIMPLE SETUP

Compaq continues to use Torx screws to bind its case together, but it has made some improvements. The three screws to remove the cover are now clearly marked. The Torx screws have slots that allow the use of a regular screwdriver if a Torx is unavailable. The slots, however, are very shallow and should only be used in an emergency. The screws holding in the expansion cards now use the same size Torx, T15, as the cover screws.

The internal arrangement is standard (see photo 2). Two full-height 5.25-inch drive bays occupy the right two-thirds of the case. The 192-watt power supply sits behind the disk bays. The system board is small, containing the 386, the 82385 cache memory controller and cache memory, a 387 socket, the system ROMs, and two custom Compaq application specific integrated circuits (ASICs). Memory, parallel and serial ports, and device controllers are connected via expansion slots.

The system configuration is set with a single, eight-switch DIP located on the system board. The switches are reasonably accessible with a long, pointed object even when a full set of expansion boards are installed. Three switches are reserved. The other five specify the presence of a coprocessor, the start-up CPU speed, the start-up display mode, and the memory configuration (256KB, 512KB, or 640KB allocated to DOS). Compaq provides a guide to the switch settings on top of the disk-drive bays for easy reference.

The multipurpose controller board has two jumpers and a four-switch DIP. The jumpers determine if the serial port is COM1 or COM2 and specify whether the board is the primary or secondary diskette/hard-disk controller. The DIP switches enable the hard disk, the printer port, and the serial port. One of the switches is not used.

The 1167 board connects to the Deskpro 386/20 via a connector board that plugs into the 387 socket. The board itself occupies slot 2. The Weitek chips generate a lot of heat, judging from the size of the heat sinks attached to them (see photo 3). The board also contains a socket for a 387. This allows the use of software that is compatible with the 387 but not the Weitek board.

UNDER THE HOOD

The Deskpro 386/20 has eight slots. Slot 1 is reserved for the memory board that uses Compaq's unique 32-bit bus to provide up to 16MB of RAM, mounted on the left edge of the unit under the side brace. The standard card contains 1MB of 120-ns, 32-bit memory. Three additional modules can be added to the memory card (see photo 4). Memory modules come in two sizes, 1MB or 4MB. A 4MB memory board is optional. The net result is up to 16MB of 32-bit memory on a single card. Compaq used 256Kbit dynamic RAM (DRAM) chips on the 1MB memory board and memory modules; 1Mbit DRAM chips are used on the 4MB board and modules. The average access time for the chips is 100 ns.

Slot 2 uses the standard 8-bit bus. If the Weitek 1167 board is used, it must be installed in slot 2. Otherwise, the slot can be used for any expansion board requiring only an 8-bit bus, such as a modem card or display adapter.

The review unit contained the Compaq Enhanced Color Graphics Board (see photo 5), which makes extensive use of surface mount technology (SMT). It features 256KB of video memory, and provides EGA-compatible text and graphics using the Compaq Color Monitor or a dual-mode monitor. When used with Compaq 386 systems, Compaq's board performs faster than other EGAs because the system's power-on self test (POST) automatically copies and remaps its video BIOS as well as system BIOS to 32-bit memory (see "Compaq Deskpro 386: The New Standard," Steven Armbrust and Ted Forgeron, March 1987, p. 48).

Slots 3 through 7 all use the standard AT-bus, providing a 16-bit data path. In all configurations, one slot is occupied by the Compaq multipurpose hard-disk controller. This card provides control for the standard diskette drive (5.25-inch 1.2MB), one optional 3.5- or 5.25-inch diskette drive, the 60MB hard disk (if installed), and the 40MB tape backup drive (if installed). The card contains a serial port and parallel port.

If either the 130MB or 300MB disk drive is installed, the companion ESDI controller must be installed in one of the AT slots. The ESDI controller is a Compaq product manufactured by Western Digital. The 135MB tape backup drive also requires a separate controller, but it can be installed in slot 8, a half-length PC bus slot.

Although only the 60MB, 130MB, and 300MB drive options are available from Compaq, the 386/20's ROM BIOS provides support for 47 types of hard disks. Table 1 lists the supported disk-drive types and their characteristics.

The evaluation unit came with the Compaq Asynchronous Board already installed. This board provides an additional serial port and parallel port. The net result (with the multipurpose controller, Compaq memory board, Weitek 1167 board, ESDI controller, tape drive controller, and display adapter) is one free AT-type slot.

The hard disk normally occupies the right bay. The 60MB drive is half-height and is controlled via the standard Compaq multipurpose controller. The 130MB (or 300MB) drive occupies the entire right bay when installed. Both larger drives use 1:1 interleave and an ESDI with a 16KB buffer to achieve their rapid performance.

The top left bay contains a standard 5.25-inch 1.2MB diskette drive. The bottom of the bay can contain a second drive (5.25-inch 1.2MB, 5.25-inch 360KB, or 3.5-inch 1.44MB) or a tape backup drive. Two tape drives are available, a 40MB or 135MB. All of these devices, except for the 135MB tape drive, are controlled by the Compaq multipurpose controller. (Some early production 1.44MB 3.5-inch diskette drives cannot reliably read double-density (720KB) 3.5-inch diskettes written on non-Compaq drives. According to Compaq, these drives were manufactured with a read tolerance that is too restrictive. Users who are experiencing this problem should contact their local Compaq dealer for a no-cost replacement.)

Adding or removing devices to or from the left bay is not easy. Because of the tightly fitted interior and the location of the retaining screws, all expansion cards and the back bracket for the expansion cards must be removed to gain access to the front screws on the side of the drive bays.

Two types of coprocessors are available with the Deskpro 386/20. The familiar one is a 20-MHz 387. This chip fits easily into a socket located on the left of the system board in front of the expansion slots (see photo 6). It can be installed easily by removing the expansion boards that cover the socket. Care must be exercised when installing it because of the extra row of pin sockets for interfacing with the second coprocessor option, the Weitek 1167 board.

Installing the Weitek board, according to the instruction book provided, requires removing the system board. This entails removing all expansion cards, disconnecting all controller

TABLE 1: *Disk Drives Supported*

DRIVE TYPE	NUMBER OF CYLINDERS	NUMBER OF HEADS	CAPACITY (MB)	LANDING ZONE CYLINDER	PRECOMPENSATION CYLINDER	SECTORS/ TRACK
1	306	4	10.65	305	128	17
2	615	4	21.41	638	128	17
3	615	6	32.12	615	128	17
4	1,024	8	71.30	1,023	512	17
5	940	6	49.09	939	512	17
6	697	5	30.33	696	128	17
7	462	8	32.17	511	256	17
8	925	5	40.26	924	128	17
9	900	15	117.50	899	−1[a]	17
10	980	5	42.65	980	−1	17
11	925	7	56.36	924	128	17
12	925	9	72.46	924	128	17
13	612	8	42.61	611	256	17
14	980	4	34.12	980	128	17
15	Reserved					
16	612	4	21.31	612	0	17
17	980	5	42.65	980	128	17
18	966	6	50.45	966	128	17
19	1,023	8	71.23	1,023	−1	17
20	733	5	31.90	732	256	17
21	733	7	44.66	732	256	17
22	805	6	42.04	805	−1	17
23	924	8	64.34	924	−1	17
24	966	14	117.71	966	−1	17
25	966	16	134.53	966	−1	17
26	1,023	14	124.66	1,023	−1	17
27	966	10	84.08	966	−1	17
28	748	16	104.17	748	−1	17
29	805	6	64.30	805	−1	17
30	615	4	31.49	615	128	25
31	615	8	62.98	615	128	25
32	905	9	104.26	905	128	25
33	748	8	104.17	748	−1	34
34	966	7	117.71	966	−1	34
35	966	8	134.53	966	−1	34
36	966	9	151.35	966	−1	34
37	966	5	84.08	966	−1	34
38	611	16	315.33	611	−1	63
39	1,023	11	190.13	1,023	−1	33
40	1,023	15	267.13	1,023	−1	34
41	1,023	15	259.27	1,023	−1	33
42	1,023	16	527.97	1,023	−1	63
43	805	4	42.86	805	−1	26
44	805	2	21.43	805	−1	26
45	748	8	101.11	748	−1	33
46	748	6	75.83	748	−1	33
47	966	5	61.82	966	128	25

[a] *A value of −1 indicates that write precompensation is not used.*

The Deskpro 386/20 BIOS supports 47 drive types. These include all the drive types supported by the IBM PC/AT, plus many more. This enables the user to choose from a wide variety of disk drive options beyond those offered only by Compaq.

connections, and unplugging all power connections. In actuality, the installation can be accomplished by removing the memory board, the RF shield next to the memory board, and expansion boards in slots 2 through 5.

STANDARD ISSUE SOFTWARE

Compaq provides three disks of software with the Deskpro 386/20, User Programs, User Diagnostics, and Advanced Diagnostics. The User Programs disk (version 5.05) includes several useful programs, including CEMM (the Compaq expanded memory manager), CACHE, VDISK, INST386, and INSTALL. TAPE, a program for using the 40MB tape backup drive, and a version of the MODE command (specifically designed

"The Breakthru 286 performed flawlessly with every application we handed it, including copy-protected programs and nine memory-resident utilities at once."
Stephen Manes, PC Magazine

"...the Breakthru 286 was the card of choice."
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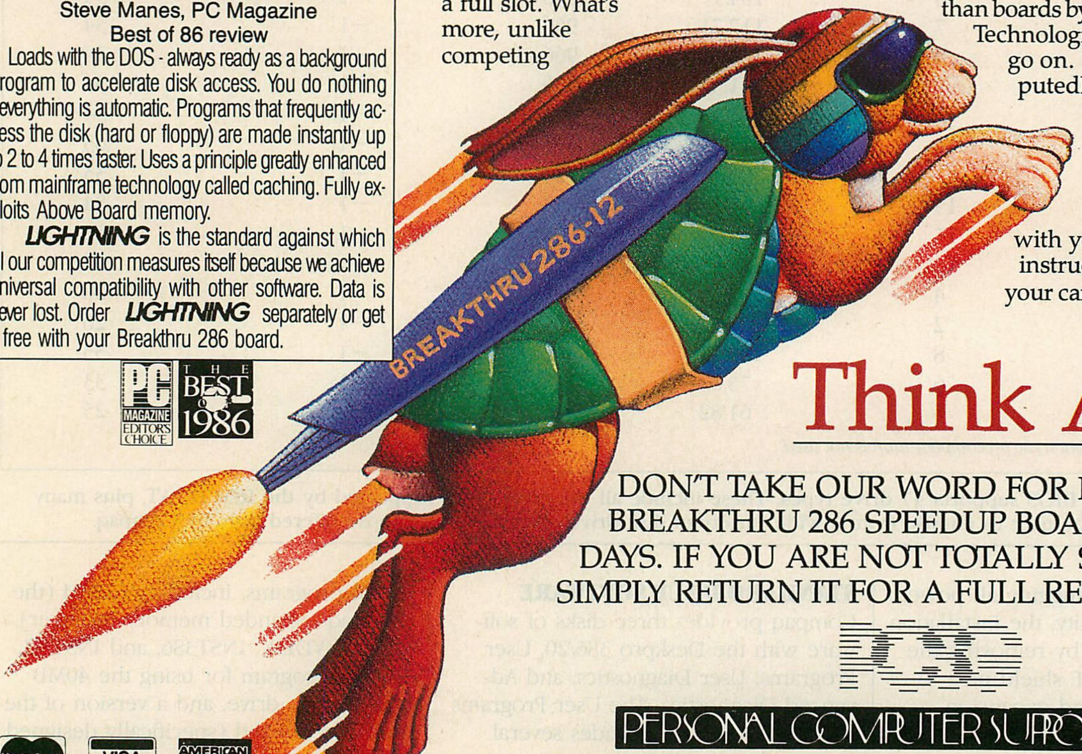

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for the Deskpro 386/20) are also included on the User Program disk.

CEMM is Compaq's solution to providing consistent use of system memory. By using CEMM, all memory can be installed as extended memory. The CEMM device driver uses the 80386's memory-mapping hardware and the system's extended memory to provide expanded memory for utilities and applications. CEMM is compatible with the Lotus/Intel/Microsoft expanded memory specification (LIM EMS) 3.2.

CACHE uses a portion of conventional, extended, or expanded memory as a disk cache to speed up disk accessing. Compaq recommends that extended memory be used for the disk cache on the 386/20. The size of the memory cache can range from 128KB, to 2,048KB, with 128KB being the default size. Because both CACHE and CEMM divide the memory with software rather than hardware settings, memory can be reallocated without removing the system cover.

INSTALL and INST386 are two menu-based programs that make the reallocation process even simpler. Both programs create or modify the CONFIG.SYS file in order to install CACHE, CEMM, and the VDISK RAM disk utilities on the system's hard-disk drive. The INST386 program is designed specifically for the 386 computers and works in conjunction with INSTALL. By using the programs, system memory can quickly and easily be apportioned between a virtual disk (or disks), extended memory, expanded memory, and a disk cache.

The MODE command on the User Programs diskette provides a 386/20 version of the processor SPEED option and the MEMCACHE option, which operates only on the 386/20.

The 386/20 uses a signal from an 8254 interval timer to lengthen the memory refresh period, in order to simulate the execution speed of slower processors. The 8254 timer is programmed according to the parameter specified in the MODE SPEED command or the BIOS interrupt 16H, AH = F0H, function request. Table 2 shows values for the SPEED option, and the system speeds simulated.

Normally, the processor speed is set in its default state (AUTO). This permits 20-MHz speed during most system operations, but still allows copy-protected programs to be loaded from diskette. However, the other settings can be used for running games or other speed-sensitive programs; this is particularly useful because speed settings are maintained during a warm reboot of the system.

TABLE 2: *MODE SPEED*

PARAMETER	SYSTEM SPEED SIMULATED
3	PC with 8088
7 or COMMON	6-MHz 80286
8 or FAST	8-MHz 80286
20	12-MHz 80286
30	16-MHz 80386
50 or HIGH	20-MHz 80386
AUTO	20-MHz 80386[a]

[a] *Switches to FAST during diskette access.*

The MODE SPEED command can be used to change the system's operating speed. This table correlates MODE SPEED parameters with the numeric values that also can be entered.

The MODE MEMCACHE command allows the 82385 cache memory controller to be enabled or disabled. The OFF parameter disables the 82385; the ON parameter enables it. Issuing the command with no parameters causes the display of the current status of the 82385 (ON or OFF). The cache controller is normally enabled.

The User Diagnostics diskette and Advanced Diagnostics diskette both contain the programs, SETUP, ROMREV, and TEST. The differences in the two diskettes are the diagnostic programs contained in hidden files. Running TEST from the User Diagnostics diskette executes USER.EXE, the Compaq diagnostic program. Running TEST from the Advanced Diagnostics diskette executes ADV.EXE, the Compaq advanced diagnostic program. Both diagnostic programs are similar to the IBM AT diagnostics, but provide more information about what is being tested.

SETUP reads the system configuration from switch settings, compares the settings with both the actual hardware in the system and the configuration stored in CMOS memory and then determines what the system configuration should be. SETUP determines most configurations properly. Once the configuration is acceptable, it is automatically written to CMOS memory for permanent storage.

In keeping with Compaq tradition, MS-DOS 3.3 with BASIC 3.0 is available at extra cost. Compaq's MS-DOS 3.3, used for this review, provides the features of IBM's PC-DOS 3.3 with some additional features. The primary attraction is the ability to have logical drives (volumes) greater than 32MB. MS-DOS 3.3 as published by Compaq allows logical drives up to 512MB in size. In addition, as many as 23 logical drives can be created using LASTDRIVE = W.

COMPAQ'S FLYING COLORS

The Deskpro 386/20's performance was tested using the *PC Tech Journal* suite of performance tests. The results of the tests are compared with the results of the tests on an 8-MHz IBM AT and the 16-MHz Deskpro 386. (For a full explanation of the tests, see "Out from the Shadow of IBM . . . ," Steven Armbrust, Ted Forgeron, and Paul Pierce, August 1986, p. 52, and "Updating the Evaluation Suite," Ted Forgeron, Paul Pierce, and Steven Armbrust, March 1987, p. 70.) Table 3 gives the test results.

ATBIOS examines the BIOS and the BIOS date areas. In the test of the Deskpro 386/20, the Compaq copyright date is 9/23/87. ATKEY tests AT keyboard compatibility. The review unit passed the test, as well as the IBM AT Advanced Diagnostic keyboard test.

ATPERF measures memory access times and CPU and math coprocessor clock rates. Video write performance using the Deskpro 386/20 EGA video controller in CGA mode is almost exactly that of a CGA installed in an AT. More video write wait states are observed because of the 20-MHz CPU speed. The processor clock rate for both the 386 and 387 is a full 20-MHz.

ATPERF verified the high performance obtainable using high-speed cache memory. Instruction fetches and RAM reads for data contained in the cache take only 100 ns (0.1 microsecond). It was necessary to update ATPERF in order to properly measure cached memory accesses. The updated version of ATPERF is available for downloading via PCTECHline.

ATFLOAT measures the time taken to perform 100 multiplications on a 20-by-20 matrix and then compares the time to that required by an 8-MHz AT equipped with a 287. The Deskpro 386/20 equipped with a 387 measures 8.5 times faster. ATFLOAT does not work with the Weitek 1167 board.

ATDISK evaluates hard-disk performance. The 300MB drive in the review system is very fast, clocking in with access times just over 20 ms. This result was obtained using an updated version of ATDISK, which can test disks with 63 sectors per track. This version also is available on PCTECHline.

Compaq has committed itself to maintaining compatibility with the AT and PC bus. This commitment is clearly shown in that all the add-in hardware

TABLE 3: *Compatibility and Performance Tests*

	IBM 8-MHz AT 80287, 30MB DISK[a]	16-MHz DESKPRO 386 80387, 40MB DISK	20-MHz DESKPRO 386/20 80387, 300MB DISK
ATBIOS			
ROM BIOS date	11/15/85	04/27/87	09/23/87
ATPERF			
Average RAM instruction fetch (μs)			
BYTE	.25	.19 (130)[b]	.10 (250)
WORD	.403	.14 (280)	.10 (403)
DWORD	N/A	.23	.12
Average RAM read time (μs)[c]			
BYTE	.401	.13/.26 (298/154)	.10/.26 (401/154)
WORD	.401	.13/.26 (298/154)	.10/.26 (401/154)
DWORD	N/A	.14/.26	.10/.26
Average RAM write time (μs)[c]			
BYTE	.401	.13/.26 (307/154)	.10/.26 (401/154)
WORD	.401	.13/.26 (307/154)	.10/.26 (401/154)
DWORD	N/A	.13/.26	.10/.26
Average ROM read time (μs)			
BYTE	.401	Same as RAM read	Same as RAM read
WORD	.401	Same as RAM read	Same as RAM read
DWORD	N/A	Same as RAM read	Same as RAM read
Average CGA video write time (μs)			
BYTE	1.208	1.21 (100)	0.94 (128)
WORD	2.415	2.42 (100)	1.86 (130)
DWORD	N/A	4.83	3.73
Average EMM read time (μs)[d]			
BYTE	.402	.13 (301)	.10 (402)
WORD	.402	.13 (301)	.10 (402)
DWORD	N/A	.14	.10
Average EMM write time (μs)[d]			
BYTE	.402	.13 (306)	.10 (402)
WORD	.402	.13 (306)	.10 (402)
DWORD	N/A	.13	.10
CPU clock rate (MHz)	8.0	16.0 (200)	20.0 (250)
Math coprocessor clock rate (MHz)	5.3	16.0 (300)	20.0 (377)
Refresh overhead (%)	7.1	15	4.4
RAM read/write wait states	1/1	0/0	0/0
ROM read wait states	1	Same as RAM read	Same as RAM read
Video write wait states (CGA)	8	17	16
EMM read/write wait states	1/1	0/0	0/0
ATFLOAT			
Performance relative to AT (%)	100	630	850
ATDISK			
Sectors/track	17	17	63
Heads	5	5	16
Cylinders	731	978	609
Total disk space (MB)	31.81	42.56	299.75
Track–track seek time (ms)	6.0	4.2	6.4
Average seek time (ms)	37.1	28.8	20.7
Effective transfer rate (KB/sec)	170.1	255.0	629.5
DOS File I/O with/without cache (sec)[e]	7.3	5.5/7.4	5.0/5.0
Interleave	3	2	1

N/A = Not applicable

[a] *The figures for the IBM AT and Compaq Deskpro 386 are the average results from several machines, whereas the results from the Deskpro386/20 were taken only from the review of the sample model.*

[b] *Figures shown in parentheses represent the relative performance expressed as a percentage compared with* PC Tech Journal*'s baseline machine, the 8-MHz, 30MB AT.*

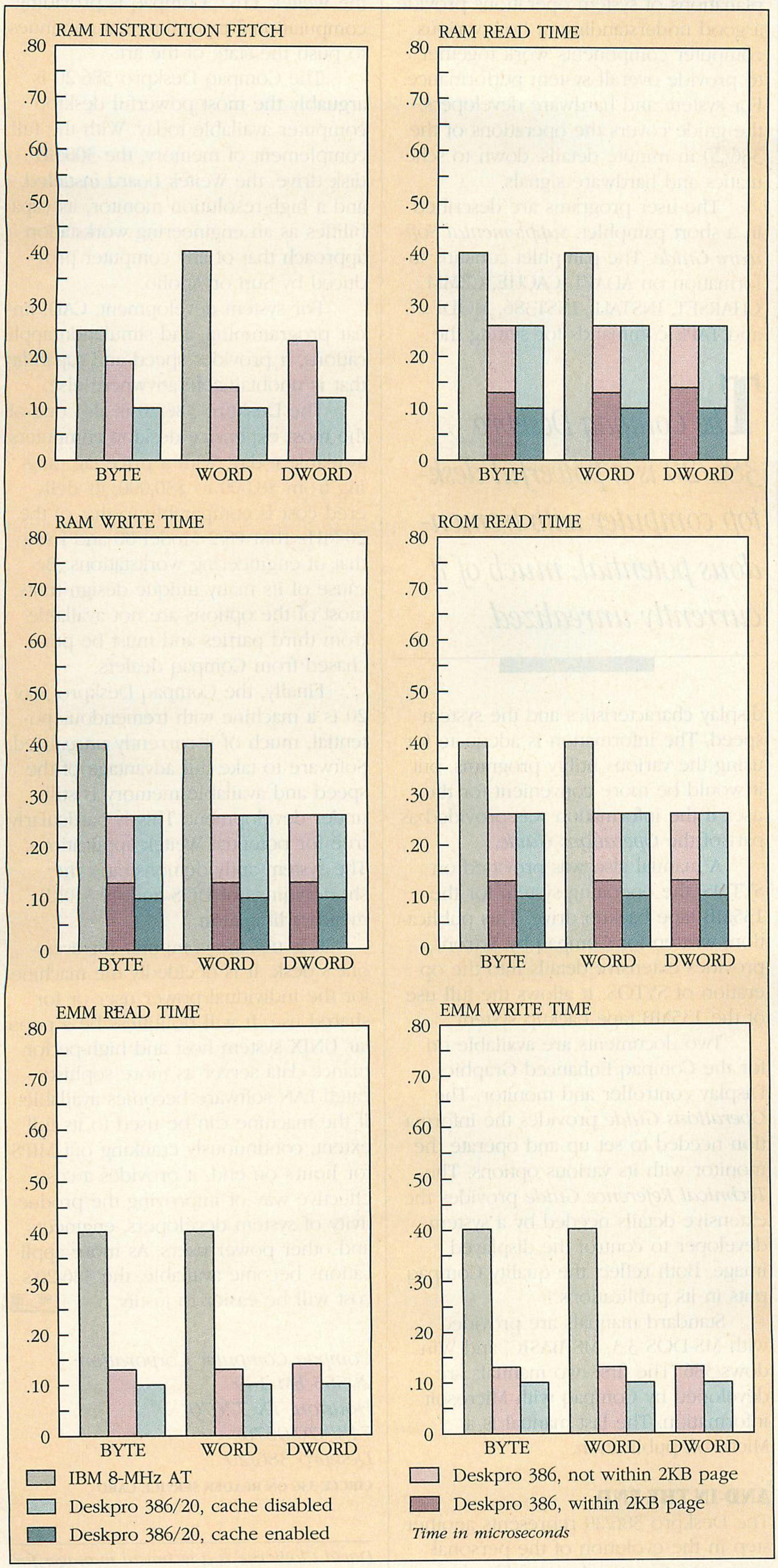
[c] *For the Deskpro 386, the first number is for memory access with the cache enabled; the second is with the cache disabled.*

[d] *EMM measurements were taken using the Deskpro 386 and Deskpro 386/20's built-in memory configured as expanded memory with the CEMM (Compaq expanded memory manager) driver.*

[e] *The Deskpro 386 and Deskpro 386/20 were tested with/without the disk caching program.*

The Deskpro 386/20's SRAM memory cache allows the 20-MHz 386 processor to read from memory with zero wait states inserted. The cache can also write to memory with zero wait states, but only if the previous memory write has completed.

FIGURE 2: *Performance Comparison*



The Deskpro 386/20 outperforms the 16-MHz Deskpro 386 and offers floating-point performance nearly an order of magnitude faster than that of the 8-MHz AT.

tested in the Deskpro 386/20 performed perfectly.

Two expansion memory cards were tested, the Intel Above Board AT and the Cheetah Combo Board. Getting the cards into the unit is not difficult, but the fit is tight. Both cards performed without problems. Because the Deskpro 386/20 comes with at least 1MB of memory (the review unit had 6MB), all the memory on both cards was designated as extended memory. Then the Compaq utilities were used to divide the memory into extended memory, expanded memory, disk caches, and RAM disks. Adding (or removing) additional memory boards does not require changing the switches on the system board, but the SETUP program must be run each time the amount of memory is changed.

In general, adding memory via the expansion boards degrades the Deskpro 386/20's overall performance. This degradation is evident when the start-up memory check slows to a crawl as it hits the chips on the Intel and Cheetah boards. It takes seven times as long to check expansion board memory as it does to check the internal memory. Using the internal memory card, the system memory can be expanded to 16MB. All of this memory is accessed on a 20-MHz, 32-bit bus via a state-of-the-art cache controller. Memory located on the expansion boards is accessed via an 8-MHz, 16-bit bus. Compaq has provided, as have other 386 manufacturers, a definite reason to use only factory memory options.

The next test involved installing the Hayes 1200B internal modem. The 1200B performed without any problems using Smartcom II. The modem can be used as either COM1 or COM2.

Both a bus version and serial version of the Microsoft Mouse were tested. The installation of the serial mouse took 30 seconds. The mouse worked fine, but, of course, used up one of the system's serial ports. The bus version also worked fine, but installation took a little longer. Instead of using up a port, it used up a valuable slot. Compaq should provide a separate, built-in mouse port. With the introduction of Windows/386 and the growing strength of graphics user interfaces, a mouse is rapidly becoming a required computer peripheral.

The first test of software compatibility was the IBM AT Advanced Diagnostics (version 2.04). The Deskpro 386/20 passed with three exceptions. The memory test recognized only 5,760KB of the 6,144KB present. This is

because 384KB of the first 1,024KB of memory is addressed just beneath the 16MB address and thus is noncontiguous with the remainder of extended memory, which is addressed from 1MB upward. The hard-disk test failed because the Deskpro 386/20 was partitioned with 100MB logical drives.

The math coprocessor test, which was designed for use with a 287, also failed because the Deskpro 386/20 uses an Intel 387 math coprocessor.

Graphics software worked without problem. Windows/386, combined with the new Microsoft Mouse, made switching from application to application a breeze. The performance of Microsoft Word 3.1 was incredible. The program loads in about 2 seconds, even with a document. Moving the cursor through the text with the PgUp and PgDn keys was virtually instantaneous.

Three memory-resident programs were tested. Borland's SideKick 1.56A and Turbo Lighting 1.01A and Living Videotext's Ready! 1.00E all performed satisfactorily. Turbo Lighting became extremely quick when the dictionaries were loaded onto RAM disks.

Ready! also uses expanded memory. Again, the program performed without incident. The expanded memory is created using the Compaq CEMM utility. Hayes' Smartcom II was used to test the communications capability of the Portable 386/20. Both the Hayes 1200B Smartmodem and the Compaq internal modem operated using Smartcom II with no problems.

Fastback, from Fifth Generation Systems, was used to test the direct memory access (DMA) capabilities of the computer. The Fastback setup program, FINSTALL, refused to allow the use of 1.2MB diskettes on the disk drive when the disk access was at 20-MHz (MODE SPEED = HIGH). Using MODE SPEED = AUTO (which sets the effective CPU speed to 8-MHz when performing diskette accesses) eliminated the problem. Other than this, Fastback performed flawlessly.

GUIDE TO RACING

The *Operations Guide*, the standard documentation included with the Deskpro 386/20, provides sufficient instructions for setting the computer up and getting it running, but it contains very little detail. Anyone who plans to use the Deskpro 386/20 for more than standard applications should have access to the *Technical Reference Guide*.

The *Technical Reference Guide*, supplied with the review unit, is invaluable in understanding the workings of the computer. It is readable on both a general and a technical level. The explanations of system operations provide a good understanding of how various computer components work together to provide overall system performance. For system and hardware developers, the guide covers the operations of the 386/20 in minute details, down to schematics and hardware signals.

The user programs are described in a short pamphlet, *Supplemental Software Guide*. The pamphlet contains information on ADAPT, CACHE, CEMM, CHARSET, INSTALL, INST386, MODE, and TAPE commands for setting the display characteristics and the system speed. The information is adequate for using the various utility programs, but it would be more convenient for the user if the information was provided as part of the *Operations Guide*.

The Compaq Deskpro 386/20 is a powerful desktop computer with tremendous potential, much of it currently unrealized.

A manual also was provided on SYTOS, the operating system for the 135MB tape backup drive. This publication, written for Compaq by Sytron, provides extensive details into the operation of SYTOS. It allows the full use of the 135MB tape backup system.

Two documents are available on for the Compaq Enhanced Graphics Display controller and monitor. The *Operations Guide* provides the information needed to set up and operate the monitor with its various options. The *Technical Reference Guide* provides the extensive details needed by a system developer to control the displayed image. Both reflect the quality Compaq puts in its publications.

Standard manuals are provided with MS-DOS 3.3, MS BASIC, and Windows/386. The first two manuals are developed by Compaq with Microsoft information. The last manual is a Microsoft publication.

AND IN THE END

The Deskpro 386/20 represents another step in the evolution of the personal computer. Compaq has produced a high-quality, well-engineered, well-manufactured machine. With innovations such as the cache memory and the Weitek 1167, Compaq is providing computational capability that continues to push the state of the art.

The Compaq Deskpro 386/20 is arguably the most powerful desktop computer available today. With the full complement of memory, the 300MB disk drive, the Weitek board installed, and a high-resolution monitor, its capabilities as an engineering workstation approach that of any computer produced by Sun or Apollo.

For system development, CAD, linear programming, and simulation applications, it provides speed and capability that is unobtainable anywhere else.

The Deskpro 386/20 is also one of the most expensive desktop computers available today. With a price tag ranging from $8,000 to $30,000, its delivered cost is comparable to that of the 20-MHz IBM PS/2 Model 80 and rivals that of engineering workstations. Because of its many unique design traits, most of the options are not available from third parties and must be purchased from Compaq dealers.

Finally, the Compaq Deskpro 386/20 is a machine with tremendous potential, much of it currently unrealized. Software to take full advantage of the speed and available memory is still under development. This is particularly true for potential Weitek applications. The system aptly demonstrates the shortcomings of DOS and its 640KB memory limitation.

It is not the computer for everyone's desk. It is decidedly the machine for the individual power user or for shared use. It will doubtless be a popular UNIX system host and high-performance data server as more sophisticated LAN software becomes available. If the machine can be used to its full extent, continuously cranking out MIPS for hours on end, it provides a cost-effective way of improving the productivity of system developers, engineers, and other power users. As more applications become available, the 386/20's cost will be easier to justify.

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Houston, TX 77070
713/370-0670
Deskpro 386/20
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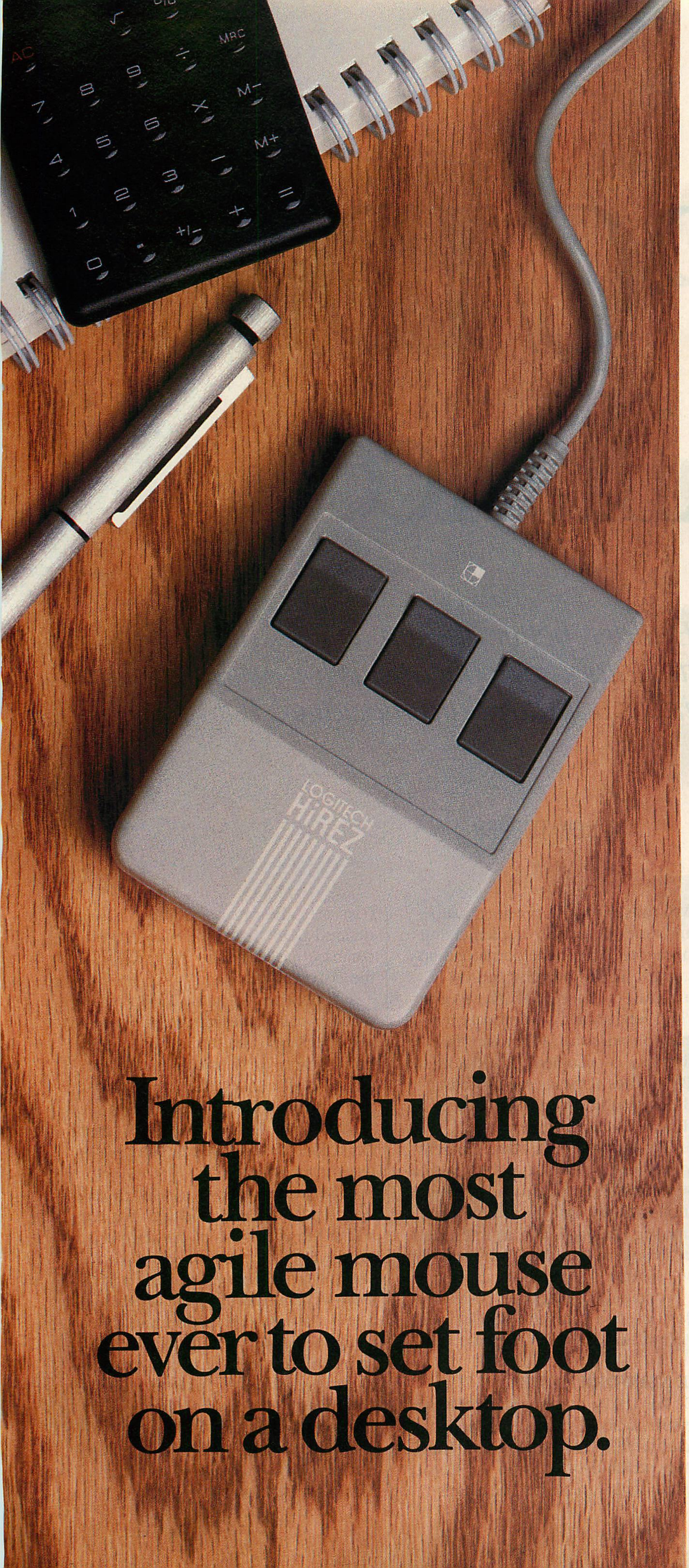
David Claiborne is a technical manager for JAYCOR in Edgewood, Maryland. He has worked with personal computers since 1982.



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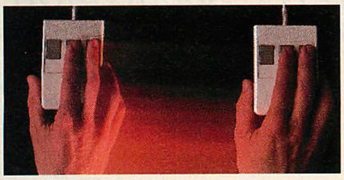

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The PC/IDMS Alliance

With The Application Builder, better known as TAB, developers can use the PC to create database applications for mainframes that support Cullinet's popular data manager, IDMS.

ANDREW TOPPER

Selling mainframe data management systems to big business is a hard nut to crack for small developers and consultants, whose PC-built applications generally cannot run on mainframes. These developers may find their nutcracker in the form of The Application Builder (TAB), Online/Database Software Inc.'s (ODS) PC-based data manager. TAB 2.02 gives PC users the power of a mainframe data manager, without incurring the high cost of a mainframe.

TAB permits development, testing, and implementation of mainframe database applications on PCs; the programs then can be run on all mainframes that support Cullinet Software Inc.'s popular data manager, Integrated Data Management System (IDMS). TAB supports almost all components of IDMS 10.0; those that it does not provide should not hinder development of IDMS applications.

Within corporations, TAB's mainframe compatibility lends itself to using PCs for developing and debugging applications and training employees on IDMS, thus reserving precious mainframe time for actually implementing applications. Mainframe-developed applications likewise can be run on PCs using TAB; therefore, TAB provides a backup for running several data manager applications on PCs when the mainframe is occupied. In addition, TAB provides a means for uploading and downloading IDMS applications to and from an IBM mainframe.

Like IDMS, the TAB development environment includes a multiuser database management system, a screen generation tool, a fourth-generation programming language, and an integrated data dictionary (see the "TAB Overview" sidebar). These tools, especially the programming language, provide a major new and complete development environment for PC developers.

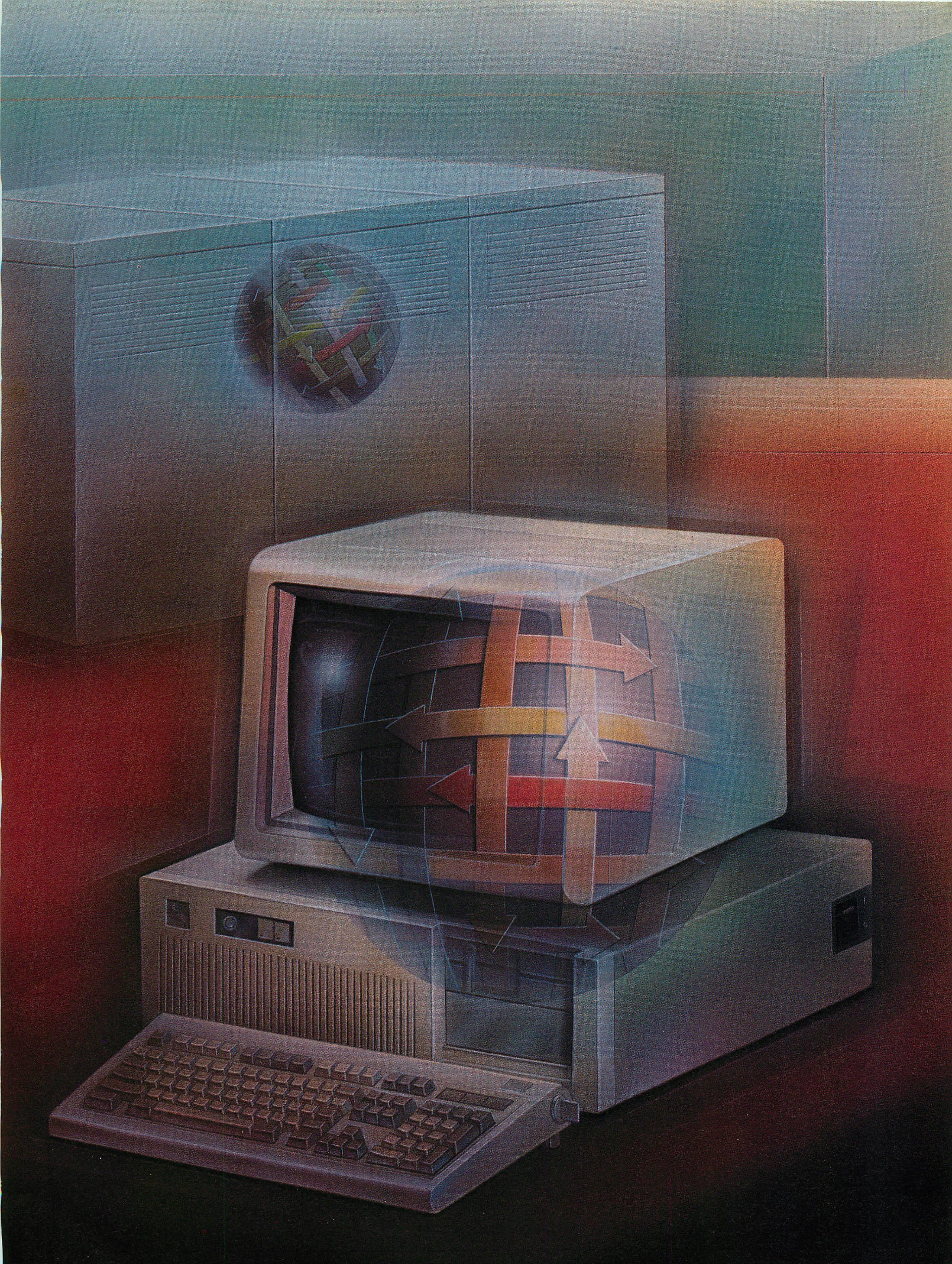
THE NETWORK MODEL

TAB, like IDMS, uses the COBOL-based network database model, originally created in 1971 by the Database Task Group, which evolved from the Conference on Data Systems Languages (CODASYL), the organization that first defined COBOL. In fact, the network database model is often referred to as the CODASYL system.

A network database design is significantly different from a fully relational design, such as Oracle Corporation's ORACLE or Relational Technology's INGRES, and it also differs from PC-based relational products, such as Ashton-Tate's dBASE III PLUS, Data Access Corporation's DataFlex, or Borland International's Paradox.

Network databases consist of records containing data and sets that represent the relationships between records, whereas relational databases consist only of tables of data with relationships dynamically defined. The relational and network models also differ in the physical definition of relationships. In most relational data management systems, relationships are defined by joining two or more tables over common fields. This duplication complicates changes to key fields because each instance of the value in the data files must be changed.

ILLUSTRATION • ANDY LEVINE



In the network model, relationships are defined as sets, with each set having an owner and one or more members. Relationships are maintained as physical links between records. The owner record can contain a pointer to the first and last member of the set; each member of a set can point to the previous or next member record and to the owner. No data fields need to be duplicated. (For a description of each database model, see "Perspective on Data Models," Clyde W. Holsapple, November/December 1983, p. 72.)

DESIGNING WITH TAB

TAB is delivered on 15 diskettes and requires 7MB to 10MB of hard-disk space. The program also comes with one key diskette and one emergency backup diskette. Installing TAB consists of running a setup program that copies the contents of the diskettes plus several supplemental programs onto the hard disk. TAB's cumbersome and error-prone copy protection scheme is a major stumbling block to using the product. Some computers that are not 100-percent IBM compatible may experience serious problems with TAB's copy protection scheme.

The brain of the TAB package is called the Central Version (TAB/CV); it is equivalent to the IDMS component of the same name. TAB/CV is the controlling program within the product that manages access to all TAB databases and tools. It also provides the runtime environment for developing and implementing applications.

TABCV is either automatically activated from the AUTOEXEC.BAT file if the user selected the AUTOSTART option during installation, or by typing TABBOOT at the DOS prompt.

After the user enters an ID and password, TAB displays its main menu. TAB's menu-driven environment simplifies the development process, especially for the beginning user. It provides access to the integrated data dictionary (IDD), the on-line mapping facility (OLM), the application development system/online language (ADS/O), as well as utilities for uploading and downloading to and from an IBM mainframe, on-line help, TAB database utilities for the developer, and a COBOL development environment.

The IDD is a key component of the TAB development system. It is a repository for all system entities. Further, it provides a wealth of project control tools to ease the implementation and maintenance of an application even after the development phase ends. (See the accompanying sidebar, "Benefitting from the IDD.")

The first step that must be taken in the design process is the creation of a logical data model or entity relationship diagram for a proposed database (which is shown in figure 1). The applications developer selects the IDD option from the TAB main menu, adds the required data elements (*fields*) and their characteristics (*attributes*) to the data dictionary, and then arranges them

TAB OVERVIEW

The Application Builder 2.02
Online/Database Software Inc. (ODS)
One Bluehill Plaza
Pearl River, NY 10965-8725
914/735-1444
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Product description. TAB provides a complete IDMS development environment for PCs that includes an on-line mapping facility (OLM), the ADS/Online (ADS/O) language, an integrated data dictionary (IDD), and the Central Version (TAB/CV).
IBM PC environment. TAB requires an IBM PC/XT, PC/AT or 80386-based computer running DOS 3.x. ODS strongly recommends an AT or 386-based computer with 6MB to 10MB of hard-disk space.
Other environments. No other environments are supported.
Network support. TAB is not currently available for multiuser systems or local area networks.
Copy protection. A key-diskette copy protection scheme is used. TAB supplies the key diskette and an emergency backup key diskette. Multiple copies of the software can be installed, and the key diskette is updated accordingly.
Documentation. An *Installation Manual*, a two-volume *User's Guide*, and a *Syntax Conversion Procedure Manual* comprise the documentation.
User interface. The menu-based system provides the traditional IDMS 10.0 environment for developing applications.
Help facilities. On-line help text for some TAB functions can be installed as an option.
File capacities. File size is limited only by the physical disk space available; fields per record and records per file have no size limitations.
Data types/capacities. TAB supports most all of the IDMS element types, including alphabetic, alphanumeric, numeric, COMP-1, bit, pointer, conditional, and group. Because TAB is written in Lattice C, the limitations from that compiler are imposed.
Data entry. Editing can be performed with edit tables stored in the data dictionary and can be enhanced with the ADS/O programming language.
Application development facilities. Online mapping (OLM) is available for painting screens. The fourth-generation ADS/O language supports block structured programming and includes modules and called subroutines. The standard IDMS programming constructs are also supported along with error messages.
Security. TAB provides for security upon entry into the development system and supports the ADS/A security structure, which limits access by users to functions of a program.
Access to system facilities. DOS functions are accessible only via the optional TAB/COBOL package, which requires a Realia COBOL compiler.
Reporting. TAB currently has no equivalent to IDMS's CULPRIT reporting package, but ODS plans to release a Structured Query Language interface in 1988 for ad hoc reporting. Batch reports can be used with the ADS/O Write Printer commands at this time.
Utilities. TAB has utilities for migration to and from disk, data dictionary reporting, database initialize/unlock, and load library maintenance.
Data compatibility. Syntax conversion is possible to and from IDMS on an IBM mainframe in IDMS Data Dictionary Definition Language format.
Distribution. TAB is available only from Online/Database Software.
Price. The main TAB module, including the IDD, is currently priced at $3,000 per unit. The OLM, ADS/O, and ADS/A can be added for $2,000 per unit. TAB/COBOL is $1,000, and the runtime system is $150.
Support. ODS provides a technical support telephone number, training at various locations around the country, and a technical bulletin board for registered users. On-site support is available for $700 a day, plus expenses; on-site training is $1,500 per day, plus expenses.

—*Andrew Topper*

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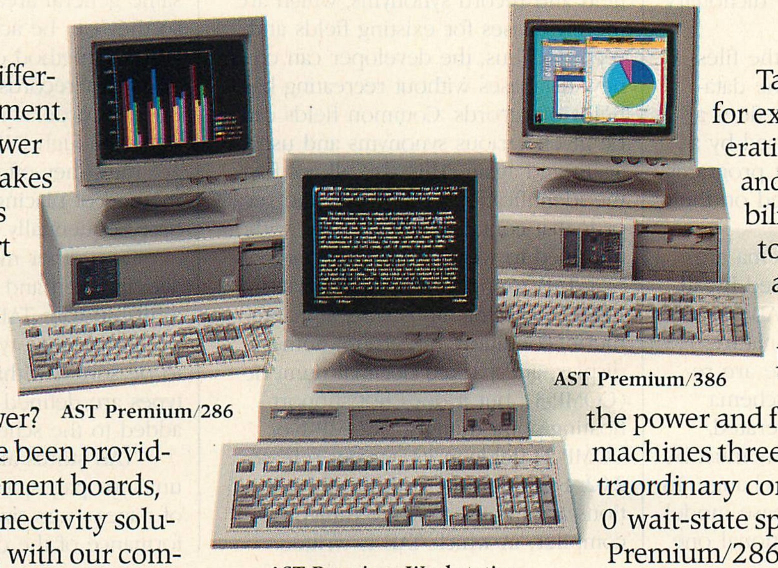

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into logical groups (*records*), as shown in figure 2.

The developer then constructs a data structure diagram, also known as a Bachman diagram, which is a physical design document detailing the physical aspects of the database (see the sidebar, "Detailing the Physical Design"). Physical database records are assigned to *areas*, which are groups of *pages* set aside for specific records; areas are, in turn, assigned to physical files. Finally, a schema and subschema are created using the components in the dictionary (see figure 3).

The schema defines all the files, areas, records, and sets for the database, while the subschema defines a view of the database to be used by a specific application. Different programs can have different views based on their particular functions.

The schema and subschema are stored in the IDD and are used by all programs executing under TAB/CV. They are somewhat static in nature; when changes to the database are required, the schema and subschema must be modified and regenerated. Likewise, all affected programs must be recompiled after a structural change. In this sense, the network database model is less dynamic than the relational one.

FIELDS, RECORDS, AND SETS

Before a schema can be defined, the developer must add fields and records to the IDD. Records are made up of fields, which can be made up of subordinate fields. For example, the date field consists of the individual fields month, day, and year. The ability to create fields and subordinate fields allows the designer the flexibility to create records that reuse existing fields from previous applications.

TAB's IDD permits the creation of field and record synonyms, which are merely aliases for existing fields and records. Thus, the developer can create new databases without recreating basic fields or records. Common fields can be given various synonyms and used again and again. This also allows for the identification of all fields and records that contain a given entity, without the need to write complex reports.

TAB supports most IDMS data fields, including alphabetic, alphanumeric, condition, bit, group, numeric display, and packed decimal numeric (COMP-3), but it does not support floating-point numeric (COMP-1 or COMP-2) fields in its current release, 2.02. Field characteristics and limitations are imposed by the Lattice C compiler, in which TAB is written.

Records are listed in the schema along with sets and any special considerations such as sort sequences and set options. Records are stored in the TAB database in one of three possible modes: CALC, VIA a set, or DIRECT. These record storage types must be determined prior to generating the schema or subschema.

A CALC record has a key field that uses a hashing function to locate a record in the database. A VIA record is a member of a set and is stored in the same general area as its owner record, so they can be accessed together. The DIRECT method of record storage specifies that records are stored in sequential order within the area specified. Although DIRECT storage records are rare, they offer the developer a method of placing records in the database sequentially.

Two other methods of record storage, indexed and system indexed, are available with TAB, but are related to the VIA storage type, allowing records to be sorted within a set. These storage types are defined when the records are added to the schema (see figure 3).

TAB stores all records on physical units, or pages; an area holds a series of pages. Page size can affect the performance of the database. In IDMS, the

BENEFITING FROM THE IDD

Both TAB and Cullinet's IDMS have an integrated data dictionary (IDD) as a key component of their development systems. Data dictionaries are fairly common on mainframe database management systems, but are somewhat less common on PC-based data managers. TAB's IDD provides a higher level of integration than other PC data managers with such dictionaries.

The IDD is simply a repository for components of an application at the various stages of its development. It contains maps, source code, tables, users, messages, and load modules.

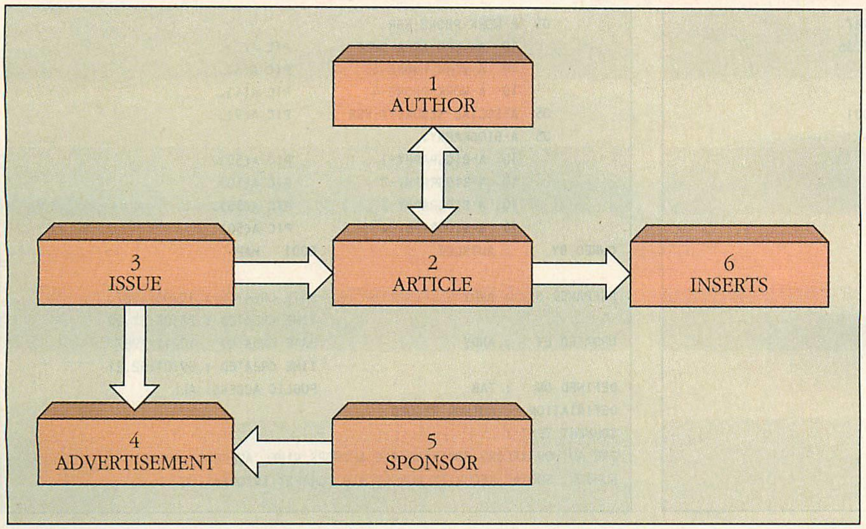
The benefits to be derived from an IDD are many:

- The components are physically related to each other in the structure of the IDD and lend themselves to impact analysis reports for the application. Because each component is linked, the developer can easily generate reports that list the records used by certain programs or the programs that use certain fields on records.
- Generation dates and times are available for each of the load modules in the IDD, allowing easy identification of components to be regenerated. For example, if a program shows a last compile time of 10:00 but its map (screen) shows a last generated time of 11:00, the program should be recompiled to ensure continuity. Likewise, the developer can generate reports that list which programs, maps, or other entities were changed after a certain date and time. The IDD provides a central place to keep updated system documentation. Each entity in the IDD has a user-supplied description that can later be used for documentation or maintenance. Individual elements (fields) and records can be described in detail in the IDD, along with function key assignments and screen layouts.
- Development staff can be given limited access to certain components of the application to facilitate project control. In TAB, only a database administrator has access to adding, changing, or deleting a schema, while programmers can have access to source code but not to schema records. This allows the project management staff the ability to ensure integrity during the application development life cycle.
- The application can be migrated easily from a test environment to production. TAB provides migration utilities for the IDD, load libraries, schema and subschema, programs, maps, and the entire application.
- Definitions of user access to the application (once it is put into a production environment) can be easily set up and maintained. Because users are simply another entity type in the IDD, the assigned security person can set them up and give them access to functions within the application, as well as give them a password.

Given these benefits, other vendors of PC-based data managers are likely to incorporate integrated data dictionaries in future releases of their products. The developer can definitely be more productive with an IDD available during the development life cycle of an application.

—*Andrew Topper*

FIGURE 1: ***Logical Data Model for the Sample Application***



The design of a TAB application begins with a logical data model diagram. The boxes represent records; the arrows are sets (relationships between records). Single-headed arrows indicate one-to-many relationships, while the double-headed arrow represents a many-to-many relationship. This particular model is for *PC Tech Journal*'s sample application for a typical editorial inventory system.

database administrator determines page size; TAB provides a default page size based on record size and set relationships. This information can be changed when it is uploaded to the mainframe, along with the number of pages per area and the page range. TAB provides no utility, such as Cullinet's IDMSPFIX, that allows the developer to examine or patch database pages if needed. In TAB, areas cannot cross over into more than one file; IDMS schemas do not impose this restriction.

In addition to defining records, the schema defines the sets that represent the relationships between records. Sets are the physical links or pointers to other records in the database. They can be set up as chained, in which the owner points to a linked list of member records; user indexed, in which a relationship is via the sort key of the set; or system indexed, in which the system record points to a linked list of records stored in CALC mode. Sets also can be created so that the next record stored within the set will always be stored first, last, next, prior, in ascending sequence by a sort key, or in descending sequence by a key. Duplicate sort key entries can be stored first, last, or not allowed within the set.

With these set options, one-to-many relationships can be established within a TAB database structure. Set pointers are under the direct control of the developer, and individual set pointers are specified in the schema. The set pointers of member records can point to the next and prior member records and to the owner record; owner records can point to the first and last member records. Set connection and disconnection options specify whether records are automatically connected to a set when stored or are manually connected by the programmer.

As programs are refined, the IDD keeps track of the records and sets they use, and TAB creates a profile of the records used by the programs. Programs that share only certain records can be grouped using a single subschema. In *PC Tech Journal*'s sample editorial inventory application, developed for its series of data manager reviews, the Author dialog can use a subschema that contains only the Author and Junction records and sets. In the event of changes to other records, programs that use the Author subschema will not have to be regenerated. (For a complete discussion of the sample application, see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46; also available on PCTECHline.)

One advantage the network database model has over the relational model is that the network database can eliminate redundant data and ease modification of key values. One disadvantage, however, is that a network database is not as flexible or as easily changed as a relational database. To change a field or a record in a file for an existing database in TAB, the user must modify the schema and subschema as well as regenerate all affected maps and dialogs.

While TAB provides a menu system for making these changes, the process of identifying the programs that must be regenerated and then making the actual modifications to the data can become quite time consuming. In order to modify a database that is not empty, the applications developer has to write two COBOL programs: one that unloads the existing data and another that reloads the data.

Cullinet's IDMS provides utilities that perform this function, as well as a restructure utility that modifies database structures in place. ODS has stated that it has plans for similar utilities for TAB in the near future.

While TAB provides an identical structure to IDMS's IDD, it has no equivalent to the IDMS Data Dictionary Definition Language (DDDL). Instead, it provides a menu-driven front end for accessing and maintaining IDD entities along with a utility for printing various reports from the IDD. While this menu system is helpful in some circumstances, a command-driver option for entering IDD commands might prove to be more useful to developers already familiar with IDMS.

Cullinet's IDD gives the developer complete control over the contents of the dictionary as well as simple commands for copying, exporting, importing, and displaying all entities in it. With IDMSDDDL, the developer can display all relevant information about traditional IDD entities as well as generated entities such as maps, dialogs, and applications. TAB provides a rudimentary mechanism for displaying information about maps and dialogs through its entity definition screen; further, it has an entity search facility that allows the user to locate an entity without knowing the exact name. This tool can be a lifesaver if printed copies of maps, dialogs, records, or schemas/subschemas are not available.

MAPPING A TAB APPLICATION

After entering fields, records, schema, and subschema into the IDD, the developer completes a TAB application by designing and implementing the following three items: *maps*, *dialogs*, and *processes*. Maps are screens composed of literal strings and variables and are used as the communications media between the data manager and the terminal operator. Dialogs are the programs that manage the database. Processes define the commands to perform a specific function within a dialog.

FIGURE 2: ***Author Record, COBOL Format***

```
ONLINE/DATABASE SOFTWARE, INC.      DATE:  11/15/1987
   THE APPLICATION BUILDER          TIME:  20:30:53.36
PRIMARY RECORD 'COBOL' LISTING      PAGE:  1

RECORD NAME     : AUTHOR            VERSION    : 0001
  LENGTH        : 306               PREFIX IS  : A-

   01  AUTHOR.
      05  A-AUTHOR-NAME.
         10  A-LAST-NAME                  PIC A(18).
         10  A-FIRST-NAME                 PIC A(12).
      05  A-ADDRESS                       PIC A(20).
      05  A-CITY                          PIC A(16).
      05  A-STATE                         PIC A(2).
      05  A-ZIP-CODE.
         10  A-ZIP-5                      PIC 9(5).
         10  A-ZIP-4                      PIC 9(4).
      05  A-HOME-PHONE-NBR.
         10  A-HOME-AREA-CODE             PIC A(3).
         10  A-HOME-PHONE-3               PIC A(3).
         10  A-HOME-PHONE-4               PIC A(4).
      05  A-WORK-PHONE-NBR.
         10  A-WORK-AREA-CODE             PIC A(3).
         10  A-WORK-PHONE-3               PIC A(3).
         10  A-WORK-PHONE-4               PIC A(4).
      05  A-SOCIAL-SECURITY-NBR           PIC A(9).
      05  A-BIOGRAPHY.
         10  A-BIOGRAPHY-1                PIC A(50).
         10  A-BIOGRAPHY-2                PIC A(50).
         10  A-BIOGRAPHY-3                PIC A(50).
         10  A-BIOGRAPHY-4                PIC A(50).
OWNED BY       : AUTHOR2                  0001   MAP

PREPARED BY    : ANDY                     DATE CREATED : 10/06/1987
                                          TIME CREATED : 23:03:31.20
UPDATED BY     : ANDY                     DATE UPDATED : 10/11/1987
                                          TIME CREATED : 09:01:52.21
DEFINED ON     : TAB                      PUBLIC ACCESS: ALL
DEFINIATION    : AUTHOR RECORD
COMMENT TEXT :
THE AUTHOR RECORD CONTAINS THE AUTHORS NAME, ADDRESS, PHONE
NUMBER, SOCIAL SECURITY NUMBER & BIOGRAPHY INFORMATION.
```

The author record in COBOL format shows all element (field) names and lengths, the total record length, and record level format. Before the schema can be defined, elements are entered into the integrated data dictionary and organized into records.

Maps are initially created using TAB's OLM facility, accessible from the main menu. The developer paints literals and variables onto a blank screen using the F1 key, known as the *start field* or *field select character*. Literals can be placed anywhere on the screen and can be given various attributes such as bright, blinking, or reverse video. Pressing F5 allows the developer to preview the map as it will appear to the user; this is useful in all stages of program development.

TAB allows for use of the standard IDMS variables $RESPONSE (or $R) and $MESSAGE (or $M) on a map as well as fields on database (schema) and work records. The $RESPONSE variable holds the last character entered by the user, while $MESSAGE displays standard messages to the screen.

Generating maps in TAB is identical to the process used in Cullinet's OLM. Maps are accessible from the main menu and can be generated by typing a G in the action field within the field selection screen. The developer creates the layout, associates its fields with database or work record elements, and assigns its attributes. Map generation uses dictionary records and elements for field definitions and creates a load module in the dictionary to be used at runtime.

Once maps have been designed and generated, they do not need to be regenerated each and every time a programming change is made. The date and time when the map is generated is stored in the IDD, providing a means of identifying discrepancies between the map and the dialog.

TAB's OLM provides facilities for verifying data entered for screen variables using tables created by the developer and stored in the IDD. These tables are associated with fields on the map when it is created. They can be of two different types: *edit* and *code*.

Edit tables provide a list of the values allowed or a list of the values not allowed to be entered for a field on a record. Edit tables have single values for each entry allowed. For example, an edit table would list the 50 state abbreviations as two-character codes. If this table were associated with a map field, OLM would provide edit checking for values in the table without any additional programming required.

Code tables allow for encoding or decoding values and for storing either value on a database record. Code tables have a set of encode and decode values. A code table, therefore, would list the state abbreviations with a two-character encode value and a string representing the entire state name.

Key assignments in TAB's OLM follow the IDMS version as far as possible, given the differences between the IBM PC keyboard and a 3270 keyboard. Wherever possible, TAB provides key placements similar to the 3270 keyboard. The PC's function keys are mapped to the 3270's program function keys (PF1 to PF24), and the Esc key maps to the Clear key on the 3270 terminal. However, the entire key set of the 3270 terminal cannot be supported completely because neither the standard nor enhanced PC keyboard provides keys such as EOF or EOL. Use of the Backspace key is inconsistent in

DETAILING THE PHYSICAL DESIGN

The data structure diagram (sometimes called Bachman diagram for developer C. W. Bachman), shown below, illustrates the conceptual view of the database, including all of the features important to network database design. Each record is characterized by a record name and number; a record type (either fixed or variable length); a record length in bytes, calculated by TAB based on lengths of data and pointer fields; a storage mode (CALC, VIA, or DIRECT); key or set name; and an area name. In the CALC mode, the key name is followed by a D if duplicates are allowed and a DN if not; in the VIA mode, the set name is given. If records are frequently accessed together, they are assigned to the same area to reduce I/O overhead.

The arrows indicate the relationship between records; the set name, types of pointers, and connection/disconnection modes are shown. Owner records can have two pointers per set, which point to the first and last member records of a set. Member records can have three pointers per set: next and prior pointers point to the next and previous member records and allow moving forward and backward through a set; owner pointers point to the owner of the set.

The connect/disconnect options include: automatic, which indicates that a record will be connected automatically on insertion by the CONNECT command; manual, which requires the connection to be made manually; mandatory, which indicates that the record can be disconnected from the set only via the ERASE command; and optional, which allows the record to be disconnected without being erased.

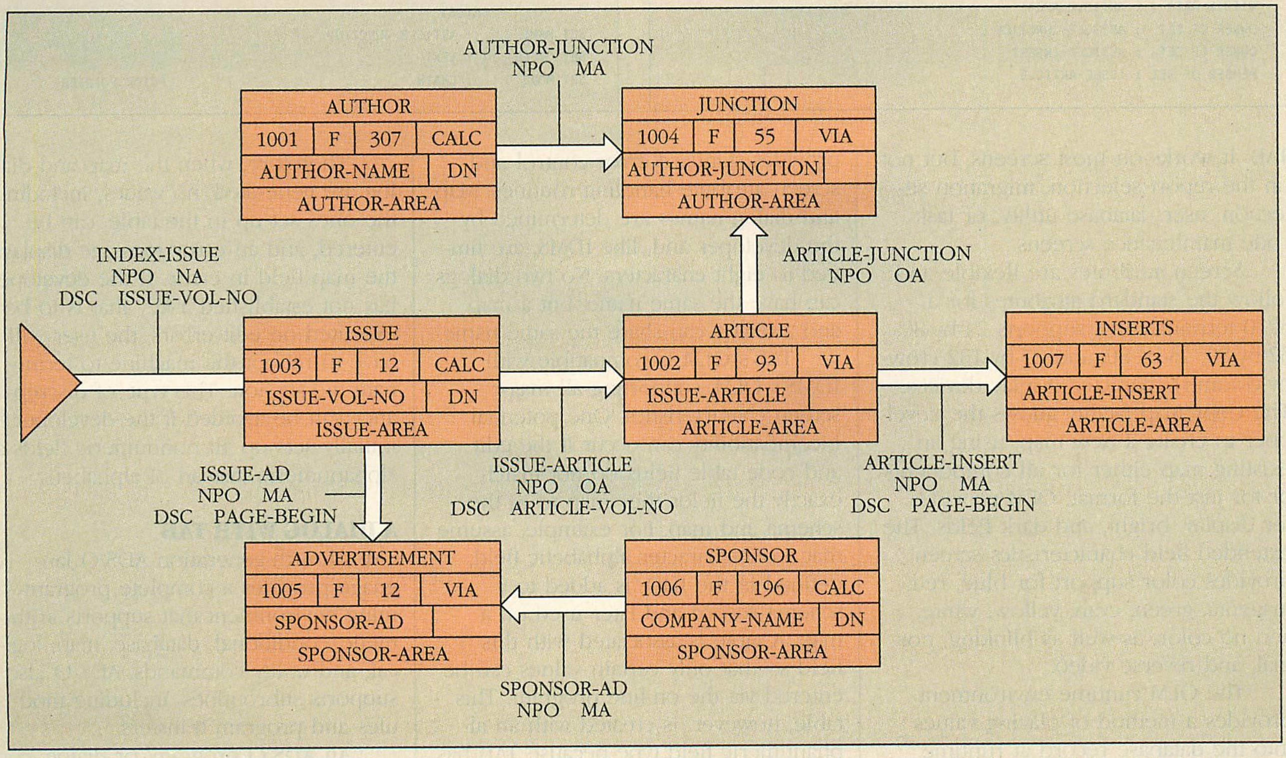
DSC indicates a sort in descending order and ASC signifies a sort in ascending order.

Sets are one (owner) to many (members); the arrow points from owner to members. If a many-to-many relationship is needed, such as between authors and articles in the *PC Tech Journal* sample application, an additional record (such as junction) is created. Because it is owned by both author and articles, the junction record can be used to find all articles written by a given author or all authors of a specific article.

The small triangle in the data structure diagram represents a system-indexed set; the system is the owner. This is used whenever all owner records are to be listed sequentially—they become members of the system-indexed set.

—MF

FIGURE: ***Data Structure Diagram for Sample Application***



A conceptual view of the *PC Tech Journal* sample application is provided in this data structure diagram (also called a Bachman diagram). All records, record lengths, storage modes, pointers, and relationships are detailed in this representation.

FIGURE 3: *Schema for the Sample Application*

```
             ONLINE/DATABASE SOFTWARE, INC.            DATE: 11/30/1987
               THE APPLICATION BUILDER                 TIME: 21:07:27.20
                   SCHEMA LISTING

SCHEMA NAME     : EDITORAL                             VERSION     : 0001
                  GENERATED

  *    SUBSCHEMA(S) LIST     *
  NAME

  EDIT0002          GENERATED
  EDIT0001          GENERATED
  EDITORAL          GENERATED

  *          FILE(S)          *
  NAME              DOS NAME

  ARTICLE           ARTICLE
  ISSUE             ISSUE

  *          AREA(S)          *
  AREA NAME         FILE NAME

  AUTHOR-AREA       ARTICLE
  ARTICLE-AREA      ARTICLE
  ISSUE-AREA        ISSUE
  SPONSOR-AREA      ISSUE

  *        RECORD(S)          *

  RECORD NAME   : JUNCTION
  IDD RECORD    : JUNCTION                             VERSION     : 0001
  RECORD LENGTH : 55
  STORAGE MODE  : VIA
  WITHIN AREA   : AUTHOR-AREA
  MEMBER OF SET : ARTICLE-JUNCTION
  MEMBER OF SET : AUTHOR-JUNCTION

  RECORD NAME   : ARTICLE
  IDD RECORD    : ARTICLE                              VERSION     : 0001
  RECORD LENGTH : 93
  STORAGE MODE  : VIA
  WITHIN AREA   : ARTICLE-AREA
  OWNER OF SET  : ARTICLE-JUNCTION
  OWNER OF SET  : ARTICLE-INSERT
  MEMBER OF SET : ISSUE-ARTICLE

  RECORD NAME   : INSERTS
  IDD RECORD    : INSERTS                              VERSION     : 0001
  RECORD LENGTH : 63
  STORAGE MODE  : VIA
  WITHIN AREA   : ARTICLE-AREA
  MEMBER OF SET : ARTICLE-INSERT

  RECORD NAME   : ISSUE
  IDD RECORD    : ISSUE                                VERSION     : 0001
  RECORD LENGTH : 12
  STORAGE MODE  : CALC    DUPLICATES NOT ALLOWED
    KEY         : I-ISSUE-VOL-NO
  WITHIN AREA   : ISSUE-AREA
  OWNER OF SET  : ISSUE-ARTICLE
  OWNER OF SET  : ISSUE-AD
  MEMBER OF SET : INDEX-ISSUE

  RECORD NAME   : ADVERTISEMENT
  IDD RECORD    : ADVERTISEMENT                        VERSION     : 0001
  RECORD LENGTH : 12
  STORAGE MODE  : VIA
  WITHIN AREA   : SPONSOR-AREA
  MEMBER OF SET : ISSUE-AD
  MEMBER OF SET : SPONSOR-AD

  RECORD NAME   : SPONSOR
  IDD RECORD    : SPONSOR                              VERSION     : 0001
  RECORD LENGTH : 196
  STORAGE MODE  : CALC    DUPLICATES LAST
    KEY         : S-COMPANY-NAME
  WITHIN AREA   : SPONSOR-AREA
  OWNER OF SET  : SPONSOR-AD

  RECORD NAME   : AUTHORS
  IDD RECORD    : AUTHORS                              VERSION     : 0001
  RECORD LENGTH : 307
  STORAGE MODE  : CALC    DUPLICATES LAST
    KEY         : A-AUTHOR-NAME
  WITHIN AREA   : AUTHOR-AREA
  OWNER OF SET  : AUTHOR-JUNCTION
  MEMBER OF SET : INDEX-AUTHOR

  *           SET(S)          *
  SET NAME      : ARTICLE-JUNCTION
  SET ORDER     : NEXT
  SET MODE      : CHAIN                                PRIOR POINTER: Y
```

TAB. It works on most screens, but not on the report selection, migration selection, user database utility, or task code maintenance screens.

Screen attributes are flexible and follow the standard attributes for a 3270 terminal. TAB supports 24-by-80, 32-by-80, 43-by-80, and 27-by-132 (row-by-column) character display devices. The Copy Map facility allows the developer to create a new map, using an existing map either for all components or for just the format. OLM provides for display, bright, and dark fields. The extended field characteristics screen provides color support for blue, red, magenta, green, cyan, yellow, white, and no color, as well as blinking, normal, and reverse video.

The OLM runtime environment provides a method of placing values into the database record at runtime without the need for special commands in the dialog. The runtime system also provides standard error control and screen attribute handling routines. Map and dialog names are determined by the developer and, like IDMS, are limited to eight characters. No two dialogs can have the same name, but a map and a dialog can share the same name.

TAB's OLM is compatible with IDMS's OLM, supporting all major screen characteristics. One potential incompatibility can occur if the edit and code table fields do not match exactly the fields they map to in the schema and map. For example, assume that a one-character alphabetic field, defined in the IDD, is added to a schema record and later used on a map. A table is associated with this field so that only certain values can be entered via the on-line program. This table, however, is created with an alphanumeric field type because TAB has no mechanism to set up edit or code tables using alphabetic fields.

Therefore, when the map and dialog are generated, no values, including the ones set up in the table, can be entered, and an error message displays the map field in error. If the developer has not established a key that is to be executed on edit errors, the user will have to reboot the machine to terminate the session. This type of discrepancy can be avoided if the developer initially sets up all nonnumeric fields as alphanumeric instead of alphabetic.

A DIALOG WITH TAB

TAB's fourth-generation ADS/O language provides a complete programming environment that supports arithmetic, conditional, database, map, logical, and utility commands. ADS/O also supports subroutines, including modules and program transfers.

An ADS/O program, or dialog, consists of a map (created in OLM), work and database (schema) records, and

```
OWNER            : ARTICLE
MEMBER           : JUNCTION                          OWNER POINTER: Y
MEMBERSHIP OPT: OPTIONAL AUTOMATIC

SET NAME         : ARTICLE-INSERT
SET ORDER        : DESCENDING
SET MODE         : CHAIN                             PRIOR POINTER: Y

---------------------------------------------------------------------
OWNER            : ARTICLE
MEMBER           : INSERTS                           OWNER POINTER: Y
MEMBERSHIP OPT: MANDATORY AUTOMATIC
SORT ELEMENT     : N-PAGE-BEGIN
DUPLICATES       : LAST
SET NAME         : ISSUE-ARTICLE
SET ORDER        : DESCENDING
SET MODE         : CHAIN                             PRIOR POINTER: Y
OWNER            : ISSUE
MEMBER           : ARTICLE                           OWNER POINTER: Y
MEMBERSHIP OPT: OPTIONAL AUTOMATIC
SORT ELEMENT     : R-ARTICLE-VOL-NO
DUPLICATES       : LAST

SET NAME         : ISSUE-AD
SET ORDER        : DESCENDING
SET MODE         : CHAIN                             PRIOR POINTER: Y
OWNER            : ISSUE
MEMBER           : ADVERTISEMENT                     OWNER POINTER: Y
MEMBERSHIP OPT: MANDATORY AUTOMATIC
SORT ELEMENT     : V-PAGE-BEGIN
DUPLICATES       : LAST

SET NAME         : SPONSOR-AD
SET ORDER        : NEXT
SET MODE         : CHAIN                             PRIOR POINTER: Y
OWNER            : SPONSOR
MEMBER           : ADVERTISEMENT                     OWNER POINTER: Y
MEMBERSHIP OPT: MANDATORY AUTOMATIC

SET NAME         : INDEX-ISSUE
SET ORDER        : DESCENDING
SET MODE         : SYSTEM INDEX                      PRIOR POINTER: N
OWNER            : SYSTEM
```

```
MEMBER           : ISSUE                             OWNER POINTER: N
MEMBERSHIP OPT: MANDATORY AUTOMATIC
SORT ELEMENT     : I-ISSUE-VOL-NO
DUPLICATES       : NOT ALLOWED

SET NAME         : AUTHOR-JUNCTION
SET ORDER        : NEXT
SET MODE         : CHAIN                             PRIOR POINTER: Y
OWNER            : AUTHORS
MEMBER           : JUNCTION                          OWNER POINTER: Y
MEMBERSHIP OPT: MANDATORY AUTOMATIC

SET NAME         : INDEX-AUTHOR
SET ORDER        : ASCENDING
SET MODE         : SYSTEM INDEX                      PRIOR POINTER: N
OWNER            : SYSTEM
MEMBER           : AUTHORS                           OWNER POINTER: N
MEMBERSHIP OPT: OPTIONAL AUTOMATIC
SORT ELEMENT     : A-STATE-ZIP
DUPLICATES       : LAST

PREPARED BY      : ANDY                    DATE CREATED : 10/11/1987
                                           TIME CREATED : 09:08:31.57

UPDATED BY       : ANDY                    DATE UPDATED : 11/24/1987
                                           TIME UPDATED : 20:36:34.23
DEFINED ON       : TAB                     PUBLIC ACCESS: ALL
COMMENT TEXT     :
THE EDITORAL SCHEMA REPRESENTS THE PC TECH JOURNAL EDITORIAL DATABASE.
THIS DATABASE CONSISTS OF THE FOLLOWING BASE RECORDS.

         AUTHOR - CONTAINS AUTHOR INFORMATION
        ARTICLE - CONTAINS ARTICLE INFORMATION
          ISSUE - CONTAINS ISSUE INFORMATION

THE FOLLOWING ADDITIONAL RECORDS WERE ADDED:

       JUNCTION - PROVIDES FOR A MANY-TO-MANY RELATIONSHIP BETWEEN
                  AUTHOR & ARTICLE
        INSERTS - ALLOWS FOR TRACKING OF FIGURES, TABLES, ETC. FOR
                  AN ARTICLE.
  ADVERTISEMENT - ALLOWS FOR TRACKING ADVERTISEMENTS WITHIN
                  AN ISSUE.
        SPONSOR - ALLOWS FOR TRACKING ADVERTISEMENT SPONSORS (COMPANIES).
```

A schema reflects the information in the data structure diagram, or Bachman diagram, and includes all records and their characteristics and all sets for the database, including pointers and connect/disconnect modes. The schema is stored in the IDD.

response processes, which are series of ADS/O commands associated with a particular key pressed by the user or with a specific response entered (a $RESPONSE). For example, a response process could be associated with the Enter or F3 keys; if either of these keys is pressed during the execution of the dialog, the code associated with that process is executed. All processes are stored in the IDD; TAB provides a process editor, accessible from the IDD, for maintenance of processes.

A special premap process can perform processing before a map is displayed. On the mainframe, these commands are interpreted at runtime.

Once a map has been created and processes associated with responses and keys, a dialog is generated. This process verifies the ADS/O commands for each response process, associates the work and database records with the program, and links the map to the dialog. The date and time that a dialog is generated are stored in the IDD along with its load module.

A dialog can be set up as a mainline program that is called from a menu or from another dialog. TAB also provides an equivalent to IDMS's IDMSBGEN utility, allowing multiple entities—maps, dialogs, and/or schemas—to be regenerated from within a batch file. These files can be saved and executed from within the batch generate utility, which keeps a log of the completion status of each entity (that is, whether or not it generated or had errors). The batch files are standard ASCII files and can be maintained using any DOS editor.

TAB's options for caching, speedup, and oversize dialog generation make efficient use of PC resources. Caching allows the developer to use cache buffers for frequently accessed fields in a dialog. Speedup creates a dialog profile that enhances the generation speed of medium to large dialogs. For dialogs exceeding 1,000 lines of code, the oversize option allows the use of the extra-large Lattice C compile and link programs. In addition, TAB can create a symbol table, diagnostic table, and activity log for each dialog via either the dialog options or dialog definition screens. These options are useful for debugging.

The TAB process editor makes entry and maintenance of a response process simple and flexible. The editor supports copy, move, insert, and delete commands on lines or blocks of lines in a process. A command line is provided for specifying search and replace values as well as for copying existing processes into new processes. The TAB editor, which is comparable to most full-screen editors, is automatically loaded whenever a process is created or modified.

TABLE 1: ***IDMS/TAB Database Commands***

COMMAND	DESCRIPTION
Bind . . .	Binds the program to the records it will be using and establishes the run unit
Ready . . . Usage is	Prepares the database areas for the program usage (shared-retrieval, shared-update, etc.)
Finish	Terminates the run unit from the data manager
Store . . .	Places a new record in the database
Modify . . .	Replaces the contents of the current record in the database
Erase . . .	Removes the current record from the database
Connect . . . To . . .	Associates a member record with its owner record
Disconnect . . . From . . .	Disassociates a member record from its owner record
If Set . . . Empty	Executes the subsequent command if the set named has no members (is empty)
If Set . . . Member	Executes the subsequent command if the current record is not a member of the set specified
Obtain Calc . . .	Locates the record named by its Key and returns it to the program
Obtain First/Last . . .	Locates the first or last member of the set (or area) and returns it to the program
Obtain Next/Prior . . .	Locates the next or prior member of the set (or area) and returns it to the program
Obtain DbKey . . .	Locates the record using the system identifier; DbKey is page number and location on page
Obtain Current . . .	Locates the current record of the type specified
Obtain Owner Within . . .	Locates the owner of the set specified

TAB supports all IDMS commands for storing and manipulating data. The commands are embedded in the dialogs written using TAB's programming language.

The entity search facility of the IDD allows the developer to key in an entity name for which to search (such as elements, records, users, tables, or processes). If an entity of that name is not found, a list of entities is displayed from which the developer can choose; alternatively, the PgUp and PgDn keys can be used to continue looking for the correct entity. This is very helpful for finding the names of records or processes. Together, the process editor and entity search facility provide benefits over the traditional IDMS tools.

The ADS/O programming language provides looping and block programing structures such as THEN DO . . . END and WHILE . . . REPEAT . . . END. Database accesses are via a series of standard IDMS commands that include STORE, MODIFY, OBTAIN, IF SET . . . EMPTY, and ERASE. In addition, the CONNECT and DISCONNECT commands allow members of sets to be manually associated or disassociated with owner records and attached to other owner records. The IDMS command structure supported by TAB provides a rich plethora of database functions that allow the developer to perform even the most complex procedures easily (table 1). The current version of TAB does not support the logical record facility (LRF) commands, which allow a defined group of records to be accessed at one time.

Together with TAB's OLM and IDD, ADS/O provides a complete development environment for mainframe and PC applications. The benefit to the developer is faster compile and generate times, more cost-effective development on PCs, and the ability to run IDMS-compatible applications on PCs.

APPLICATION SUPPORT

Like IDMS, TAB provides application support that allows multiple dialogs to be associated with a specific task. IDMS's ADS/Application (ADS/A) utility provides a generator for combining the entities needed for the application; a similar product, accessible from the utilities menu, is available with TAB.

The components and structure of an application under TAB can be migrated en masse to the mainframe. One of the key components of a TAB application is the ability to set up and enforce security for the functions within the application. These are directly tied to the IDD user definitions.

It should be noted that the version of TAB reviewed here (2.02) does not

provide support for a multiuser or multitasking environment. These capabilities may be added in a future release (see the accompanying sidebar, "Late-breaking Improvements").

TAB comes with several utilities that help the developer in creating and testing an application. The TABINIT utility allows an existing database to be initialized, similar to IDMSINIT. The TABUNLK utility resets the locks on a database. TABMIGR1 and TABMIGR2 provide a means of migrating portions of the TAB system to diskette. This allows the system to be backed up and restored easily, similar to the IDMS utilities, IDMSBKUP and IDMSRSTR.

TAB also supplies a utility, called TABDMLE, that allows the programmer to access any record in the database without writing a program—this is helpful in determining if data are being accessed or stored correctly in a dialog or batch program. TABDMLE is limited in how much data can be loaded or erased at a given time. This utility is similar to a product created for IDMS called Data Manipulation Language/Online (DMLO) from DBMS Inc.

Although TAB's development environment is very nearly equivalent to IDMS's, it does lack some key utilities. For example, it has no programs that facilitate database changes after data are placed in the database files; IDMS, on the other hand, has an Unload and Reload utility, which allows existing data to be unloaded to another file and reloaded from that file to the changed database without the developer having to write a COBOL program. IDMS also has a database restructure program, which TAB does not, for making changes to an existing database in place. ODS has plans to implement these utilities in the future.

THE TAB/COBOL CONNECTION

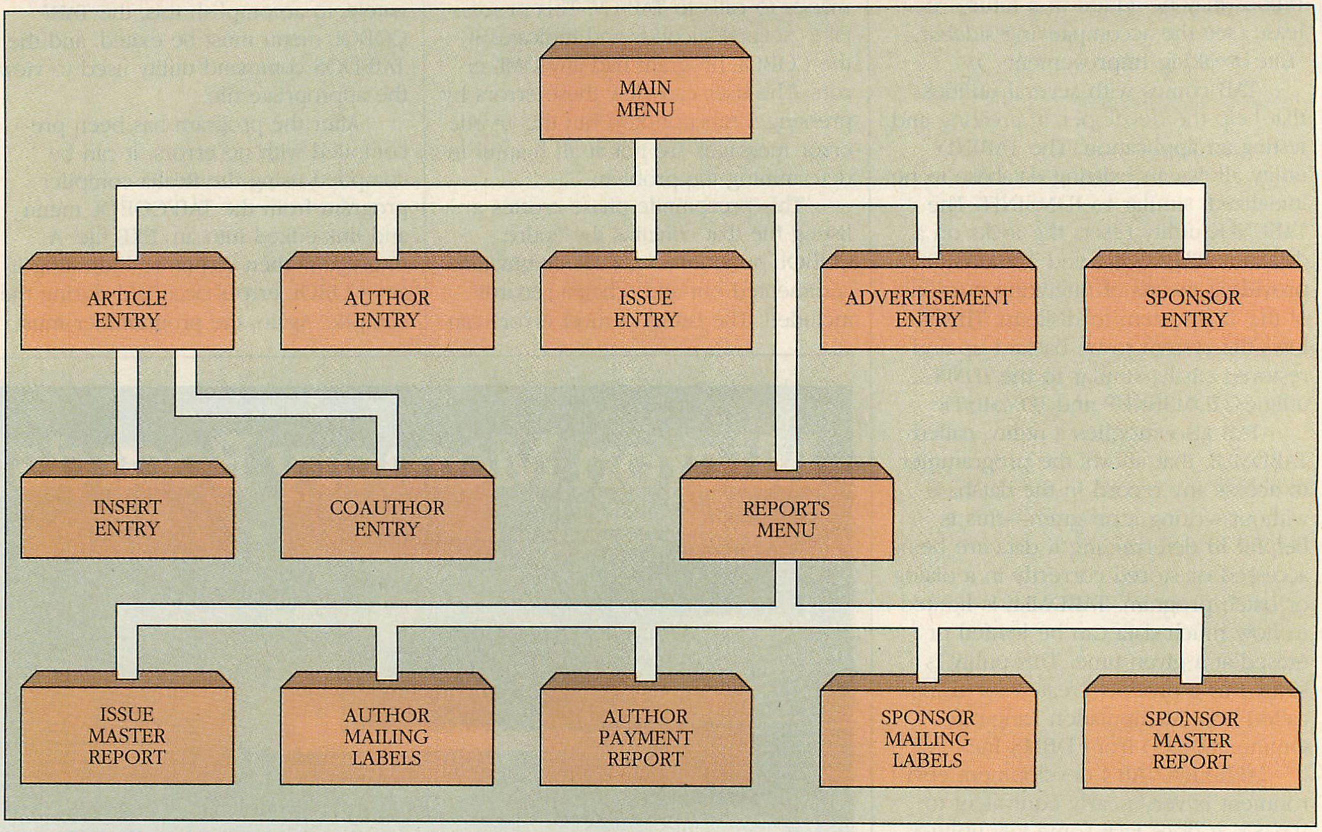
The separate TAB/COBOL package provides a complete batch development environment for COBOL programs using a TAB database. (ODS plans to provide an IDMS/DC COBOL development and execution environment in a future release.) The package requires the Realia COBOL compiler and provides a precompiler to translate TAB Data Manipulation Language (DML) commands into calls to TAB/CV (see table 1). The Realia compiler supports the ANSI standard COBOL with extensions for IBM VS COBOL level 2. The TAB/DML precompiler supports all IDMS COBOL DML commands.

Once a COBOL program is created, the TAB/DML precompiler, available from the TAB/COBOL development menu, converts the database commands to calls to TAB/CV. This process takes several seconds and indicates if the COBOL program had any DML errors. The user can view these errors by pressing a function key, but the cryptic error messages are not at all helpful in determining the problem.

This precompile phase creates a listing file that contains the entire COBOL program with DML commands commented out and schema records included. The cause of most errors can be determined by viewing the output file from the precompile step. Unfortunately, to accomplish this, the TAB/COBOL menu must be exited, and the TAB/DOS command utility used to view the appropriate file.

After the program has been precompiled with no errors, it can be compiled using the Realia compiler program from the TAB/COBOL menu and link-edited into an .EXE file. A message is then displayed indicating if any COBOL errors occurred during the compile. Again, the programmer must

FIGURE 4: ***Dialog for the Sample Application***



A dialog is the ADS/O program that manages the database. The dialog structure for implementing the *PC Tech Journal* sample application includes modules for entering data and for running reports, all of which are accessible from the main menu.

view the file created by the compiler (filename .LST) from outside the TAB/COBOL menu in order to determine the cause of the errors.

The TAB/COBOL compile and link edit step worked correctly with version 3.0, but not 1.2, of the Realia compiler. The TAB documentation, however, fails to state which version is required.

RUNTIME SUPPORT

TAB's runtime program TAB/CV controls access to TAB's database and IDD through a centralized group of reentrant data management routines. Like its IDMS counterpart, TAB/CV adds an extension to the operating system by loading its routines into memory and forcing all accesses through the resident data management routines. Whenever programs request TAB records, TAB/CV performs the actual file reads that are necessary and returns the record to the executing program. If a program requests a change to the database, TAB/CV creates an entry that provides a means of restoring any updates following a program termination. These functions of TAB/CV are identical in concept to IDMS and its Central Version on the mainframe.

TAB/CV provides the following runtime functions:

- It controls the flow of data to/from a program and a database file. This means that all database accesses, including IDD updates, are performed through TAB/CV.
- Concurrent accesses or updates to a database are handled by a single copy of the data manager routines. This allows pages to be locked and records to be kept in memory until a program has finished with them.
- TAB/CV keeps track of all programs running (called *run units*). Run units are complete sequences of database accesses and updates performed by a program. A program that starts under TAB/CV is assigned a run unit ID to identify it while it is executing.
- TAB/CV protects against deadlock by preventing two or more programs from accessing a database record during an update to that record. Database records are locked during updates to prevent this from happening; TAB/CV releases the locks only after the run unit has successfully completed executing.
- Because all TAB applications use the same routines, the accesses to database files can be optimized for maximum efficiency. For example, pages that have been read can be retained in memory until they are replaced by other pages.
- Programs that abnormally terminate can be rolled out without affecting other programs running. TAB/CV issues a rollback command for those run units that have terminated and removes any updates to the database made by those programs.

The current release of TAB has no equivalent to the IDMS journal file, which logs all database activity, but ODS plans to add this feature in a future release. The journal file can be used to reverse all updates performed. Updated records are locked and other programs wishing to access the records are kept waiting. TAB/CV will not let those other programs have access to the updated records until the lock has been removed. The trade-off is that if records are locked, other programs can wait a long time before they are given access by TAB/CV. With a journal file in place, an audit trail for transaction-oriented applications can be generated easily, and batch updates can be rerun with little programming effort.

FIGURE 5: *Sample Response Process Code*

```
PROCESS NAME     : AUTHOR-ADD                          VERSION     : 0001

  PROCESS CODE  :
READY AUTHOR-AREA USAGE-MODE IS UPDATE.

OBTAIN CALC AUTHORS ALLOWING ('0326').
IF DB-REC-NOT-FOUND THEN DO.
  STORE AUTHORS.
  INIT'(AUTHORS).
  DISPLAY MESSAGE TEXT 'AUTHOR ADDED TO FILE'.
  END.

DISPLAY MESSAGE TEXT 'AUTHOR ALREADY EXITS - USE F6 TO MODIFY'.

  PREPARED BY    : ANDY                     DATE CREATED : 10/10/1987
                                            TIME CREATED : 17:36:45.98
  UPDATED BY     : ANDY                     DATE UPDATED : 11/08/1987
                                            TIME UPDATED : 10:27:42.19
  DEFINED ON     : TAB                      PUBLIC ACCESS: ALL
-----------------------------------------------------------------------
PROCESS NAME     : AUTHOR-CHANGE                       VERSION     : 0001

  PROCESS CODE  :
READY AUTHOR-AREA USAGE-MODE IS UPDATE.

MODIFY AUTHORS ALLOWING ('0813').
IF ERROR-STATUS EQ '0813'
```

```
  DISPLAY MESSAGE TEXT 'PLEASE VIEW AUTHOR BEFORE CHANGING'.

INIT (AUTHORS).
DISPLAY MESSAGE TEXT 'AUTHOR RECORD UPDATED'.

  PREPARED BY    : ANDY                     DATE CREATED : 10/10/1987
                                            TIME CREATED : 17:38:20.02
  UPDATED BY     : ANDY                     DATE UPDATED : 11/08/1987
                                            TIME UPDATED : 10:28:25.52
  DEFINED ON     : TAB                      PUBLIC ACCESS: ALL
-----------------------------------------------------------------------
PROCESS NAME     : AUTHOR-DELETE                     . VERSION     : 0001

  PROCESS CODE  :
READY AUTHOR-AREA USAGE-MODE IS UPDATE.
READY ARTICLE-AREA USAGE-MODE IS UPDATE.

ERASE AUTHORS PERMANENT MEMBERS.

INIT (AUTHORS).
DISPLAY MESSAGE TEXT 'AUTHOR HAS BEEN DELETED'.

  PREPARED BY    : ANDY                     DATE CREATED : 10/10/1987
                                            TIME CREATED : 17:42:00.65
  UPDATED BY     : ANDY                     DATE UPDATED : 11/08/1987
                                            TIME UPDATED : 10:28:02.07
  DEFINED ON     : TAB                      PUBLIC ACCESS: ALL
```

Response process code can be written quickly and easily using TAB's fourth-generation ADS/O programming language. The three processes that are shown here add, change, and delete author records for the sample editorial inventory application.

TABLE 2: *Benchmark Performance*

BENCHMARK TASK	TIME	AVERAGE TO DATE
Add 900 records to an empty database table	600	168
Index table on two fields (7 bytes)	—[a]	53
Document and tally codes from one column	210	47
Mass change of one column (28 rows of 900)	44	20
Extract selected records to create a text file	4	12

All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB hard disk under DOS 3.0.

[a] *This benchmark was deemed not applicable due to the time and effort involved in adding the index to the existing database (see text).*

Benchmarks one and three are much slower than average, due in part to the overhead of maintaining pointers and to the fact that import requires COBOL code.

TRYING TAB OUT

Applying *PC Tech Journal*'s sample editorial management application to TAB meant the creation of eight dialogs and maps (including menus), a schema and subschema, and several batch programs for loading data, as well as the generation of reports. The reporting programs were written as COBOL batch programs. Unfortunately, TAB lacks a reporting package such as Cullinet Software's CULPRIT for IDMS that allows the developer to create all forms of reports to run against IDMS databases. Such a reporting utility would greatly enhance TAB and provide additional compatibility with the mainframe system that TAB emulates.

The sample application design involved creating a logical data model of the records for the application (see figure 4). The data structure diagram, or physical database design, required assigning records to areas, determining record sizes, and establishing location mode and set names (see sidebar, "Detailing the Physical Design"). From the diagram a schema and subschema were generated (figure 3). Response process code for the sample application is given in figure 5.

One problem encountered when loading the sample data was due to TAB's failure to support lowercase letters in ADS/O programs. All data entered are converted to uppercase. Because the sample data were mixed case, none of the records could be accessed by key after loading the file; only uppercase letters could be input. Thus, all the data had to be converted to uppercase before loading.

ODS claims TAB supports scratch and queue records (work records maintained in the IDD), but during the sample application, these records could neither be stored (using PUT) nor retrieved (using GET). According to ODS, scratch and queue records should be available to all programs running under TAB/CV and are generally used for communications between batch programs and ADS/O programs.

Scratch records are sometimes used for auditing purposes. Whenever a record is deleted from a system, a copy is stored in a scratch record, which later may be moved to an archive file. The user can specify a retention period, during which time the scratch records are saved; when the retention period is over, the scratch records are deleted automatically by TAB/CV. Queue records are saved by TAB/CV across system shutdowns, whereas scratch records are not.

The ADS/O LINK command, used for passing work records between dialogs, also proved problematic during testing. A work record could not be passed between dialogs with the data intact. Whenever this was attempted, the data displayed in the receiving dia-

log appeared as garbage or were uninitialized. Schema records and database currencies, however, were passed without problems.

Disk space was also a concern when running the sample application. Upon installation, TAB used almost 8MB of the hard disk; by the end of the application, TAB required 18MB. Given that the sample application is small in scale, the estimated disk space requirements for a large development effort could reach the 40MB to 50MB range. TAB technical support suggests initializing the load and object libraries periodically to reclaim unused disk space and regenerate existing load and object modules with the batch generate utility. With TAB 2.1, however, this should not be a problem (see the sidebar, "Late-breaking Improvements").

TAB TIMES

The *PC Tech Journal* benchmarks for data managers consist of five tests: adding 900 records to the database; creating an index; counting the number of occurrences of a specific code in a file; changing all occurrences of a code; and extracting selected records to create a text file—with and without the benefit of an index.

The second benchmark was omitted because adding the index to the existing database would have involved a significant amount of work and time: creating, testing, and running a COBOL program to unload the existing data to an ASCII file using the existing subschema; modifying and regenerating the existing schema to add the index (and all subschemas affected by the change); initializing the database using the new schema; creating, testing, and running a COBOL program to reload the data from the ASCII file created in step 1 above; and regenerating affected dialogs and maps.

All other benchmarks, except the last one, ran considerably slower than the average data manager. Loading 900 author records was accomplished in 600 seconds; documenting and tallying codes took 210 seconds, and changing the state code took 44 seconds. The time required to find all authors with state code of CA, sort by zip code, and write an ASCII file was 4 seconds, but this was based on using the existing index on state and zip code.

REFINING A GEM

TAB is an important product for businesses that want to use PCs to develop IDMS applications that are to be implemented on mainframes. This is quite an accomplishment given the limitations of the PC. Not only does TAB's compatibility with IDMS mean added flexibility in data management, but the cost savings can be staggering for a major corporation offloading some or all of its IDMS development onto PCs.

TAB's most positive features include its ADS/O programming language, which provides a complete development environment, and its IDMS-like integrated data dictionary and on-

LATE-BREAKING IMPROVEMENTS

Version 2.1 of TAB, released just prior to publication of this review, provides significant performance enhancements as well as a substantial decrease in load module size over version 2.02. The decrease in generation time for maps, dialogs, and tables is noticeable. Smaller load module sizes make a significant dent in the amount of disk space that TAB eats up.

The previous release of TAB places load modules into the file, TABLOADL.PDS, upon generation. When new copies of the load module are to be added to this file and the assigned slot does not have enough space, a new slot is created. This leads to duplication of load modules with no way to remove them except to initialize the library and regenerate all maps, dialogs, and tables.

Release 2.1 removes the existing slot, thus reducing space requirements. Because the size of the load modules has decreased, the issue of adequate disk space addressed in the review may now be moot. As an example, the original load library for the sample application database under 2.02 grew to more than 7.5MB. The load library for 2.1 is only 230KB.

The new version allows dynamic loading of maps and edit and code tables. It also has a new dialog abort screen and the ability to generate syntax conversion files either by date and time created or by date and time last modified. This makes the syntax conversion process much easier to use because TAB's elements, records, and other entities can be excluded from the conversion.

With the latest release, TAB also provides a way to exit to DOS, which is supposed to allow full DOS command functionality. However, the new version still does not support DOS SET and PATH commands from within TAB. The work-around solution is to exit TAB completely, type the DOS command, and then return to TAB.

Online/Database Software claims that TAB 2.1 now supports paging of maps. ODS also has added two utilities: a disk optimizer to consolidate fragments of files and free space; and a utility that removes TAB/CV from memory without booting. Also available now are TAB/SQL to enable Structured Query Language queries against a TAB database, and TAB/C to provide C routines for accessing and updating TAB databases.

A NETWORK IN THE FUTURE

ODS has announced a network version of TAB to be released this year. According to the company, TAB/NET will run on any NETBIOS-compatible local area network, including IBM's Token-Ring, Novell's NetWare, 3Com's 3Net, and AT&T's StarLAN. The system will provide for transaction processing with a LAN file server, which will house the TAB development and runtime environments. It will reportedly run as either a dedicated or nondedicated Central Version (CV) server that will contain the data dictionary and user databases. TAB/NET will allow up to eight workstations per CV server, with multiple CV servers per LAN server.

In addition, TAB/NET is supposed to support concurrent processing at the CV server level. This will allow all database, area, and record locking to include exclusive and shared retrieval and update modes under TAB. Each attached node will be seen by the CV as a separate run unit, and the CV will monitor activity and statistics both on-line and through batch printing. This will provide control over maximum users, maximum locks, run unit cancellation, and system start-up and shutdown.

TAB/NET will run on an IBM AT or compatible and will require 640KB of RAM on the workstations, 640KB on the CV server and the LAN server, and at least 10MB of hard-disk space. ODS recommends using an 80386-based computer for the LAN and CV servers. No information is yet available regarding site licensing or prices for TAB/NET.

—*Andrew Topper*

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line mapping facility. Complex mainframe applications have been developed with ADS/O, which has reduced the development time in large projects. TAB's implementation of ADS/O supports almost all of its mainframe counterparts, with the exception of paged maps and role names.

The key-driven OLM uses a painting method for developers to create screens and provides immediate verification of data entered via the enter and code tables. TAB's menu-driven interface is strikingly simple and useful; it substantially reduces the time required to implement a complex application. Another valuable feature is the IDD's entity search facility, which permits users to locate a record, element, or schema without knowing its name.

In some respects, however, TAB is still an unpolished gem. It lacks the following: support for a logical record facility, the ADS/O LINK command (when work records are passed between dialogs), and schema areas that overlap files. Its scratch and queue records do not work properly.

Because no utilities are available for unloading, reloading, or restructuring databases, maintenance in TAB is slightly more difficult than in IDMS. With no internal data dictionary definition language for displaying records and maps, dictionary reports must be run each time a schema record or element needs changing in order to determine the impact.

Furthermore, TAB developers must write their own reporting programs in COBOL. The addition of an equivalent of IDMS's CULPRIT report package would benefit all TAB developers. The minor inconveniences of certain PC keys working with only certain screens is also a nuisance.

Online/Database Software needs to improve TAB documentation considerably in order for the product to be accepted by non-IDMS developers. For the most part, TAB documentation consists of photocopies of TAB screens with a one- or two-line definition of the values allowed for each field. This type of documentation provides little if any help to the beginning TAB user and limited help to more experienced IDMS users. Some sections are missing entirely. The index is cumbersome and provides nothing more than a list of references to the words used in the different sections.

Finally, TAB's full power cannot be realized until a multiuser and multitasking version becomes available, including a multiuser data dictionary and multitasking TAB/CV. (ODS is developing a networked version of TAB to provide multiuser features; see the sidebar.) TAB also should benefit from the increased power of OS/2 and other new operating systems available for the IBM family of computers; this will allow TAB users to run more than one application and component at a time.

With the exception of the documentation, the cumbersome key-disk copy-protection system, and its few missing features, TAB is a worthwhile product. It combines the PC benefits of an integrated menu-driven interface with the mainframe power of IDMS.

The bottom line is that using TAB can significantly reduce the cost of developing IDMS applications. It can open the mainframe data management marketplace to PC developers and permit greater corporate flexibility in data management. Large applications such as accounting, manufacturing, and financial investing can be developed, tested, and run on PCs with TAB.

Andrew Topper is founder and director of Foresite Systems, a consulting and applications development firm near Lansing, Michigan. He has five years of experience with IDMS, both as a programmer and as a database administrator. He is currently involved with developing applications for PCs.

DATA MANAGERS AS
DEVELOPMENT TOOLS

Complexity Made Simpler

KENT PHELPS

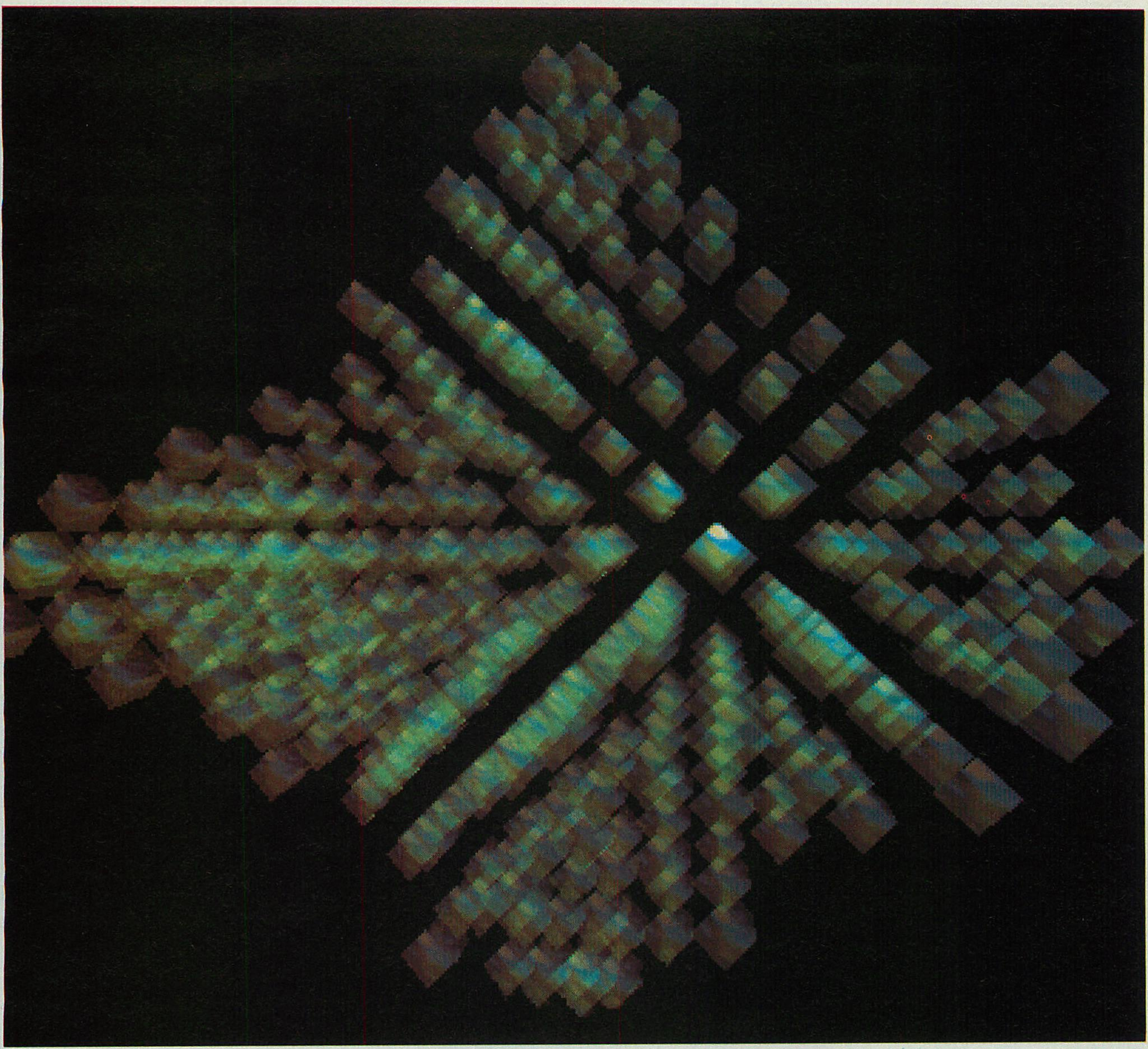
Like its predecessor Revelation G, Advanced Revelation tackles complex applications—but now with a distinguished user interface and streamlined development tools that uncomplicate the complicated.

Advanced Revelation, the third release from Revelation Technologies, maximizes the attributes of its predecessors by boasting a distinguished user interface and progressive tools to ease development.

The icing on the cake is that the interface is menu driven, well organized, employs extensive help windows, and supplies extra features to enhance the system and free developers from having to program extensively in the R/BASIC programming language. It permits inexperienced Revelation developers to use the product's unique and splendid PICK-like capabilities to create applications without learning the command set or having extensive knowledge of the product's complex file structure. Besides courting users and developers, Advanced Revelation also relies more on PC/AT architecture than the previous release, Revelation G (see "A Data Manager Designed for Complex Applications," Kent Phelps, February 1986, p. 160).

A new and improved data manager for complex applications, Advanced Revelation does the following:

- Creates entry screens, reports, and file-update programs quickly, in most cases without the need to write code, yet retains the ability to insert custom code when needed.
- Allows major changes to be made to an application quickly and cleanly. Automatic resizing of variable-length records precludes the need to restructure files when adding fields.
- Operates effectively on a network. The developer decides what files should be available for network access; Advanced Revelation provides individual record locking.
- Integrates well with other DOS programs. To execute small DOS programs, Advanced Revelation can drop into the DOS environment while remaining in memory. To perform a large DOS application (a word processor or a spreadsheet), Advanced Revelation can suspend by using a Rollout file to store the Advanced Revelation machine state on disk and release all but 9KB of RAM.
- Allows developers to customize a master environment record unique to each user by accessing the record and changing parameters.
- Offers numerous methods for cross referencing and indexing.
- Introduces helpful features: keystroke capture for building macros or transaction logging for crash recovery; ability to add to or replace system functions in windows with prepro-



cesses, postprocesses, and at-prompt processes; read, save, and delete record processes; and define the environment, video attributes, system security levels, and privileges.

Revelation's strength historically comes from its underlying PICK operating-system structure and concepts. The original Revelation is a direct PC implementation of the minicomputer PICK/PRIME Information relational data manager, complete with syntax and command structure. Like its predecessors, Advanced Revelation is based on the relational model of data management (see "A Perspective on Data Models," C. W. Holsapple, July 1984, p. 113 and "Database Design Techniques," Dave Browning, July 1987, p. 112).

Data are logically stored in three-dimensional matrices, called *dynamic arrays*, that are implemented as strings. Advanced Revelation uses a data dictionary, can perform dynamic file joins, and can read and update as many files as needed in a single program.

To put all of Advanced Revelation's cards on the table, *PC Tech Journal* has run a sample application and benchmarks for the product. The review is one in a series being conducted on data managers (see "Evaluating Data Managers as Development Tools," Julie Anderson, August 1985, p. 46).

The sample application consists of the Issues file, which stores the issue volume, number, and deadline date; the Authors file, which stores the name, address, phone numbers, and a biographical sketch of each author; and the Articles file, which stores the type and length of each article, its author, and payment data. The application examines the data manager's ability to complete ad hoc reports and queries for such typical tasks as printing mailing labels, importing and exporting data, and tracking information such as number of pages booked into an issue or total amount paid to an author.

NUTS AND BOLTS

Advanced Revelation's menu-driven interface is superb. The main menu accesses all features: designing data-entry windows, menus, reports, macros, and pop-ups (small help screens from which users make selections or get information); accessing windows and reports; using tools; managing the system environment and accounts; and exiting to DOS or the command level (TCL), which is Advanced Revelation's interactive command language. Development is done with TCL or by navigating through menus (see figure 1).

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ADVANCED REVELATION VITAL STATISTICS

Advanced Revelation
Revelation Technologies
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Bellevue, WA 98006-9910
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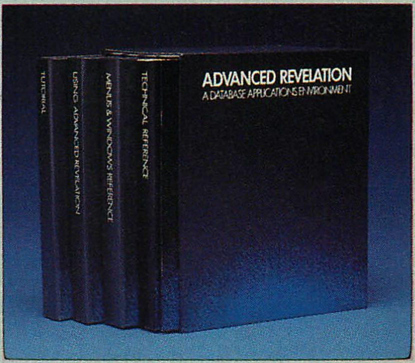


Product type. A database-management system and applications environment for use in developing sophisticated business applications.
Software environment. Runs under DOS (2.0 and later) and TopView.
Network support. Supports IBM Token-Ring, Gateway, Nestar, Novell, Gateway, Corvus, PCNet, Banyan Systems, Santa Clara Systems.
Hardware environment. PC/XT, PC/AT, and IBM compatibles with a minimum of 512KB RAM, a hard disk and one diskette drive. Company recommends an 80286- or 8386-based computer with 640KB RAM. A math coprocessor is supported.
User interface. The program is command-language and menu-driven and uses macros/procedures and function/control keys. The command language, data definition, and data manipulation are all English-like.
File capacities. Records limited to 65,535 characters; unlimited number of fields; unlimited records per file; unlimited open files; unlimited indexes per file. Program allows a file to span multiple disk volumes, and stores data in variable-length records. Files automatically resized. Extensive use of data dictionary.
Access to system facilities. From within the program the user has the ability to access all DOS functions.
File-modification facilities. Program can merge two or more files into a single file and can split a file into two or more files. Can update a file with data from another file, and update multiple files simultaneously. The user can add fields without loss of data in a file.
Help facilities. On-line, context-sensitive help, a written tutorial, and a quick reference card are provided.
Field types. Supports derived fields using information resulting from calculations, another file, and a user-supplied list or file of acceptable values. Other field attributes allow for view-only fields, numeric fields, user-defined numeric formats, must-enter fields, and double-entry fields forcing operator to reenter information to verify accuracy.
Data entry. Automatically checks for duplicate entries in a file; provides range-checking functions; allows the user to supply standard entry values during entry; and provides facilities for batch data entry.
Query and sort. Search facilities allow for partial key search and selection and logical operators. Sorts can be performed in ascending and descending order. Supports multiple sort operations on up to 128 fields and multiple indexes on unlimited fields. Query and order specifications can be saved for repeated use. Supports automatic updating of indexes.
Reporting. Produces label reports that make 2-or-more-across labels. Report formats can be edited and contain information from two or more files. Produces summary reports that can include totals, subtotals, control breaks for pagination, and calculated results using four-function math, parenthetical control of order of operations, averages, and trigonometric, transcendental, and string operations. User can specify paper size, margins, and the like in report definition. By using forms created in Paint mode, data can be output anywhere in virtual form space.
Security. Provides password-protected access to program and fields. Multiple levels of password protection and multiple restrictive levels on application windows are available.
Utilities. File-maintenance utilities, conversion utilities for translating dBASE and Lotus files, and printouts of report and file-design definitions.
Application development facilities. Uses a screen-painting method that allows custom data-entry screens. User can create multiple data-entry screens for a single file, which can be more than one screen long. Customization is possible with macros/procedures and custom-menu generation. Provides fully programmable procedural language, links to DOS applications or other languages, and can generate turnkey applications. Runtime compiler or module is available.
Data compatibility. Reads Lotus, dBASE, comma-delimited ASCII, and fixed-length ASCII file formats.
Special features. Integrated, variable-length, and variable-width text windows within screen generator.
Availability. Since September 1987.
Distribution. Distributors, dealers, system houses, and consultants.
Price. Runtime version, $200; Network Revelation 4-user license, $1,445; 10-user license, $2,435; 32-user license, $4,910.
Support. Includes on-screen tutorials, sample applications, telephone support, demonstration disk, and end-user training. Extended hotline support available for $200 per year.

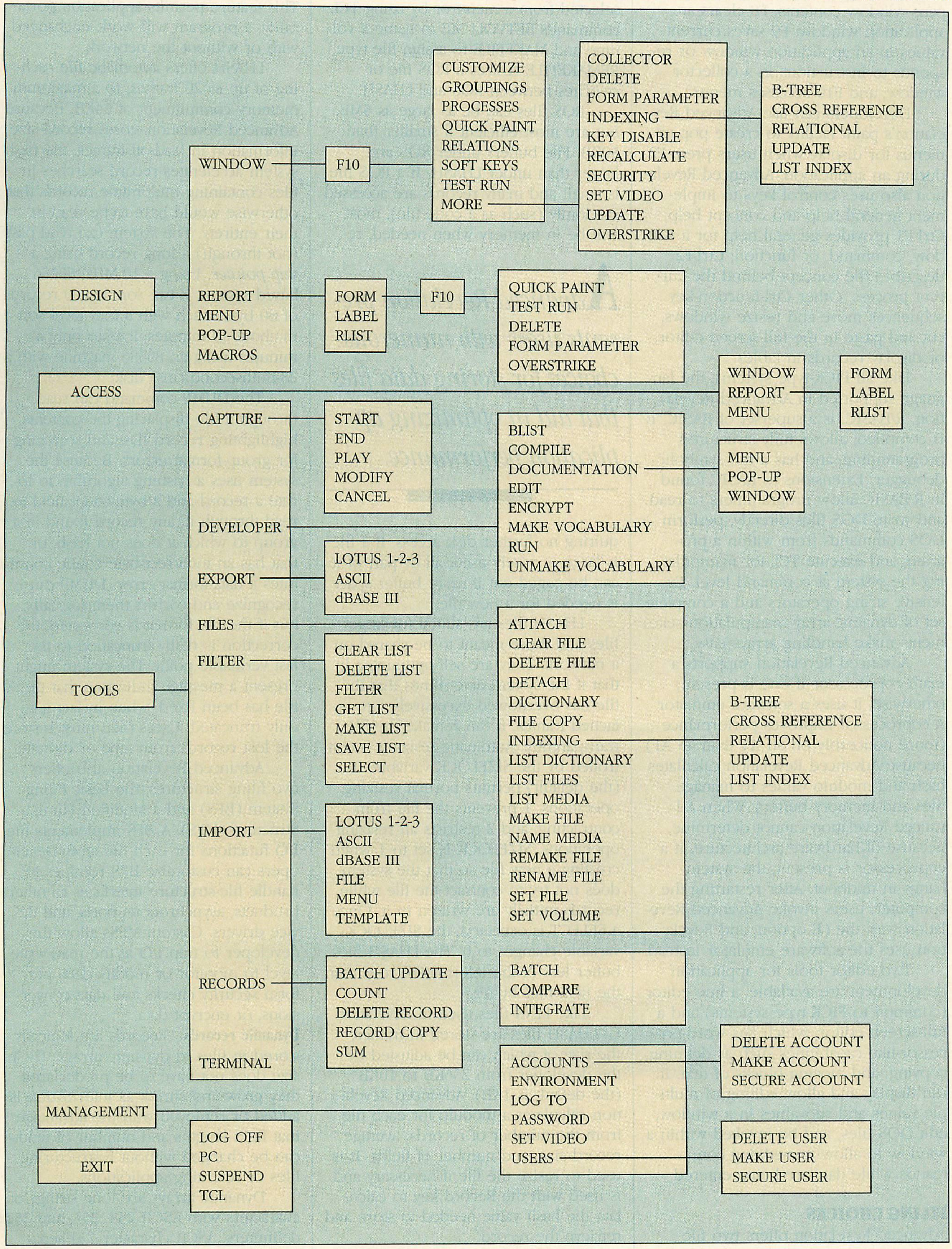
—Kent Phelps

System instructions (such as Create file, Delete file, and List file) are available from a menu selection. They also are available using TCL, which automatically checks developer-entered syntax and provides corrections if necessary. Therefore, typing the command line perfectly is no longer necessary. Extensive use of pull-down menus and the company's new pop-ups (which prompt for selections rather than typed responses) can speed execution of tasks such as developing screens, tutorials, and menus in an application.

Developing an application requires windows to interact with the data manager. Application windows are used to enter and modify data in an application; collector windows accumulate information needed to execute a process.

Users manage windows with specified keys and keystrokes. In a menu, the F1 key calls up general help about the current window prompt or function selected; in an application, F1 calls up the text help provided by the developer. F2, the Options key, displays choices for the current prompt. If a cross-reference index is available, F2 accesses a small prompt window requesting cross-referenced input and consults existing indexes. F3 zooms in on a window entry; F4 toggles the edi-

FIGURE 1: ***Advanced Revelation Menu Hierarchy***



Applications can be developed in Advanced Revelation by using the command language (TCL) or by making selections from the menus. The Design option on the main menu leads to the major development tools. The Access option brings up windows, menus, and reports developed. Tools provides utilities, and Management sets the security and environment parameters.

Adapted from Revelation Technologies' Using Advanced Revelation

tor off and on; F5 accesses TCL; F6 displays soft keys when in paint mode; F7 pans window contents; F8 clears an application window; F9 saves current values in an application window or responds to instructions in a collector window; and F10 accesses menus.

Developers can use Advanced Revelation's paint facility to create pop-up menus for display when users press F2 during an application. Advanced Revelation also uses control keys to implement general help and concept help. Ctrl-F1 provides general help for a window, command, or function; Ctrl-F2 describes the concept behind the current process. Other Ctrl-function-key sequences move and resize windows, cut and paste in the full-screen editor, or display records in tables.

Like all PICK-type systems, the language supported in Advanced Revelation, R/BASIC, is a superset of BASIC. It is compiled, allows fully structured programming, and has a full symbolic debugger. Extensions to BASIC found in R/BASIC allow programmers to read and write DOS files directly, perform DOS commands from within a program, and execute TCL for manipulating the system at command level. Extensive string operators and a complete set of dynamic-array manipulation statements make handling arrays easy.

Advanced Revelation supports a math coprocessor if one is present; otherwise, it uses a software emulator. A coprocessor improves performance (more noticeably on an XT than an AT) because Advanced Revelation calculates hash and modulo values to manage files and memory buffers. When Advanced Revelation cannot determine, because of hardware architecture, if a coprocessor is present, the system hangs in midboot. After restarting the computer, users invoke Advanced Revelation with the (E option, and Revelation uses the software emulator instead.

Two editor tools for application development are available: a line editor (common to PICK-type systems) and a full-screen editor, which has word-processor-like capabilities such as defining, copying, and moving blocks of text. It can display and allow editing of multiple values and subvalues in a window, edit DOS files, and be invoked within a window to allow text-editing commands while data are being entered.

FILING CHOICES

Advanced Revelation offers two file types: ROS files (similar to Revelation G) and the new linear hash files (LHASH), Advanced Revelation's default. ROS files cannot be shared on a network; LHASH files can. File types are selected from a menu or by using TCL commands SETVOLUME to name a volume and MAKEFILE to assign file type. REMAKEFILE resizes a ROS file or switches between ROS and LHASH.

ROS files can be as large as 5MB, but are most efficient if smaller than 50KB. File buffers under ROS are larger than under LHASH. If a ROS file is small and many records are accessed randomly (such as a code file), most will be in memory when needed, requiring no further disk access. If a file is large or rarely used, all or part of it can be paged out if more buffer space is needed for a new file.

Advanced Revelation presents users with numerous choices for storing data files that aid in optimizing application performance.

LHASH files are suited for large files and those meant to be shared on a network. They are self-optimizing in that if the system determines that the file has overflowed excessively into attached frames, it can remake the file transparently. Automatic resizing is controlled by the SIZELOCK variable: 0 (the default) permits normal resizing operations, 1 prevents the file from contracting, and 2 restricts all resizing operations. SIZELOCK is set to 1 when creating a new file so that the system does not try to contract the file while records initially are written to it. Once a SELECT is executed, the SIZELOCK variable changes to 0. The LHASH files buffer less of the information read than the ROS files buffer.

Like LINK files used in Revelation G, LHASH files are stored in frames, the size of which can be adjusted by the developer from 256KB to 10KB (the default is 1KB). Advanced Revelation calculates a modulo for each file from the number of records, average record size, and number of fields. It is used to resize the file if necessary and is used with the Record key to calculate the hash value needed to store and retrieve the record.

On a network, LHASH files accommodate record locking. R/BASIC code can include the LOCK and UNLOCK statements, which are ignored for single-user and unshared operations. This feature permits application portability; a program will work unchanged with or without the network.

LHASH offers automatic file caching of up to 20 frames, to a maximum memory commitment of 64KB. Because Advanced Revelation stores record size information in lead-off frames, the hash system accelerates record searches in files containing multiframe records that otherwise would have to be read in their entirety. The system can read past (not through) a long record using a *skip pointer*. Using a 10-MHz, 80286-based system, it can sort 12,000 records of 80 bytes each with a four-level sort in about 10 minutes; it takes only 4 minutes using an 80386 machine with a 28-millisecond (ms) disk.

The DUMP command can read through a file displaying the contents, highlighting record IDs, and searching for group-format errors. Because the system uses a hashing algorithm to locate a record and a byte-count field to read through it, any record found in a group to which it does not hash, or that has an incorrect byte count, constitutes a data-format error. DUMP can recognize and correct them logically, but if the file format is corrupted, the correction is really truncation to the last verifiable point. The system might present a message indicating that the file has been fixed, when in fact it is only truncated. Users then must restore the lost records from tape or diskette.

Advanced Revelation also offers two filing structures, the Basic Filing System (BFS) and a Modified Filing Structure (MFS). A BFS implements file I/O functions for each file type. Developers can customize BFS routines to handle file-structure interfaces to other products, asynchronous ports, and device drivers. Custom MFSs allow the developer to trap I/O at the read-write level to monitor or modify data, perform security checks and data conversions, or encrypt data.

Dynamic records. Records are logically stored in files in dynamic arrays. Their size does not have to be predeclared; they grow and shrink as information is added or removed with the advantage that field lengths and number of fields can be changed without restructuring files or rewriting applications.

Dynamic arrays are long strings of characters with ASCII 254, 253, and 252 delimiters. ASCII character 254 separates the record into fields, ASCII character 253 separates the fields into values, and ASCII character 252 separates

values into subvalues. The system translates the long strings (real format) into a user-specified format (such as date, money, or numeric values).

In Revelation, a record is limited in size to 65,535 characters but has no functional limit on number of fields, values, or subvalues. Fields can be of variable length and are either single-valued or multivalued. For example, the work-phone field of an author record could be defined as a multivalued field allowing more than one phone number to be stored in a record.

Revelation and PICK use data dictionaries for each file as a central repository of information on format, computational rules, and field names used in each record; these dictionaries link users to processes (such as reports, forms, and windows) that require field names. Revelation also uses dictionaries to store precompiled object code, input editing rules, and help information about the dictionary item. When users request a file listing, the system creates an ad hoc program that links in precompiled code to extract data from the file and to convert the data to output format; these unique programs are created in just a few seconds. Once the listing is finished, the program is discarded.

Revelation controls most of the system from the data dictionary; the proper dictionary in place therefore aids construction of useful data-entry screens and expedites reports. To display or input the same field several different ways, simply build alternative dictionary items (synonyms).

Rolling indexes. Indexing in Advanced Revelation is vastly improved over Revelation G, which like most PICK systems is not index driven. Rather, it depends on high-speed sequential reading of a database to select records meeting certain criteria. An indexed system offers higher performance than sequential reading but requires more maintenance, has greater potential for failure because of corrupted indexes, and retrieves only those records based on existing indexes. Advanced Revelation addresses these problems by providing three types of indexes: B-tree, cross-reference, and relational. (For simple processing, a Quickdex feature, accessed from the dictionary window, keeps a sorted list of a file's record keys in a dictionary record.)

B-tree indexing is used when the goal is to index the entire contents of a field. It is lightening quick, but it retrieves only those records having a complete and perfect match.

Cross-reference indexing retrieves records that match a word or a character string in the index field, thus returning a larger number of records. The developer can specify which field is to be cross referenced and what delimiters are used to parse the cross-referenced item. The developer then specifies the stop list that contains words or strings that must be eliminated because they are too frequently encountered and could potentially overload the cross-reference system. Typical stop words for a customer database are CO, INC, THE, and AND.

Relational indexing defines a relationship between master and detail tables (a one-to-many relationship). A customer record might have an arbitrary number of item records added to an invoice file. A relational index maintains relationships between master/detail tables, even if new records are added or deleted from a file.

Developers choose and create indexing systems from the Dictionary window, from the Indexing option available on the More Paint Functions menu when painting a window, or from the Tools File menu. Through the Indexing menu, the developer can list all current indexed files and update or rebuild all or individual indexes.

A subtle strength of the various indexing schemes is that indexing is relegated to a true background task with all necessary hooks in the right places. Unlike Revelation G, where a record being edited with the editor could disrupt the index structure, all system processes in Advanced Revelation can update any existing indexes.

Because corrupting indexes is almost as inevitable as death and taxes, operations to maintain, update, and rebuild indexes are essential to an indexing system. When working with indexed fields, developers control how often Advanced Revelation updates indexes as a background task by setting a parameter in the environment record. Advanced Revelation utilities (from the Tools Files menu) update and rebuild all indexes for a single file, specific fields in a file, or all indexes in all files. When processing an ad hoc query using R/LIST (the system's retrieval language), Advanced Revelation determines if the fields used are indexed. If so, R/LIST reports perform faster.

PAINTING AN APPLICATION

Advanced Revelation provides a variety of tools for developing complex applications (see table 1); primary among them is the painter. Developers can use

TABLE 1: ***Application Building Tools***

TOOL	DESCRIPTION
Paint	Data-entry window designer
Pop-up designer	Pop-up message and process designer
Menu builder	Application menu designer and processor
Edit	R/BASIC source-code editor
Macro builder	Command save and replay utility
R/LIST	Nonprocedural query language
Dictionary window	Dictionary builder
The Command Level	System command language
Other	Other software used with Advanced Revelation

Advanced Revelation provides a comprehensive set of tools to develop applications, including Paint, which designs windows, Pop-up, which creates pop-up messages, Menu Builder, Edit, Macro Builder, R/LIST, and Dictionary Window.

it to create windows (data-entry screens), reports, and menus. It is invoked from the main menu by selecting Design (then Window or Report) and specifying the data file to be used. At any Advanced Revelation menu, pressing F2 pops up a help screen displaying other available menus, including main design—a fine example of Advanced Revelation's nonrigid menu structure that allows users to invoke tools anywhere in the system, using recursive command levels.

With the painter, the developer can drag prompts around singly or in groups and can adjust the field length (see photo 1). Multivalued fields and associated windows are created simply by defining more than one entry line for a prompt. If a single-value data-dictionary item is updated or other dictionary parameters are changed, the painter updates the dictionary with the new status, if desired.

The painter can bind a prompt in a window to corresponding fields in a file via Auto, Verify, Off, and Number modes. Autobinding (the default) usually is used when defining a new file for which no dictionary exists. As data prompts are entered from the painter, the system uses dictionary defaults to create new dictionary records. Data fields are assigned in the order that prompts are entered; the system binds each prompt to a related dictionary item created on the spot.

Verify mode is used when prompts being painted on the screen are to be associated with existing dictionary records. If the prompt matches a name in the dictionary, Advanced Revelation displays a pop-up that allows binding to a field of the same or a different name; otherwise, a pop-up prompts for creation of a new field or binding to an existing field having a different name.

To create a screen in Autobind or Verify mode, a prompt is typed as it should appear on screen. If it is two or more words, such as "Balance Due," the system combines the words with an underscore making the corresponding dictionary entry a contiguous string ("Balance_Due"). The item is then acceptable to the system but still retains the prompt familiar to the user.

If a dictionary already exists, binding can be turned off so that paint does not create or update the dictionary when prompts are entered. Number binding does not require a dictionary because it is used in collector windows that pass information from the user to R/BASIC routines.

The Quick Paint option renders rapid prototyping as long as a data dictionary exists. The developer selects available dictionary items in the order they should appear on the screen. The system then paints a default screen format. This does not necessarily produce the nicest screen but it is fast. Once the logic of the screen is validated, the developer can rearrange prompts or change the labels and text to make the screen more attractive.

Pop-ups are created separately and quickly from the records in a file, the fields in a record, or the values in a field. The painter is so good that once during development of the *sample application*, when a particular screen from the original application did not convert completely, it was quicker to repaint than convert it.

Revelation G's R/DESIGN screen processor has limited ability to restructure the screen; deleting the screen and generating a new one is often quicker than making continuous modifications. The best the R/DESIGN can do is create a screen that passes for the default mode of Advanced Revelation.

Window tools. Advanced Revelation has many features to tailor windows and reports. A Customize submenu allows specifying borders, highlights, reverse video, and similar features of an individual window. Dictionary items can be created to join multiple data files at once, and windows that address specific data files can be related so that multiple files and windows can be accessed during data entry.

In the sample application, the Article entry window attempts to confirm that the issue being referenced is in the Issues file. If the user attempts to enter an article into an issue that is not in the Issue file, the Article window reports that the issue is not on file. The user simply presses Shift-F3 (or another key of the developer's choice) to suspend the current (Article) window and transfer to the Issues window, where the appropriate information can be entered. On exiting the Issues data-entry window, the user is returned to the Article window at the point of departure. To accomplish this multiwindow access, the developer need only define related windows; under Revelation G substantial custom code is required, making this feature available only to experienced developers.

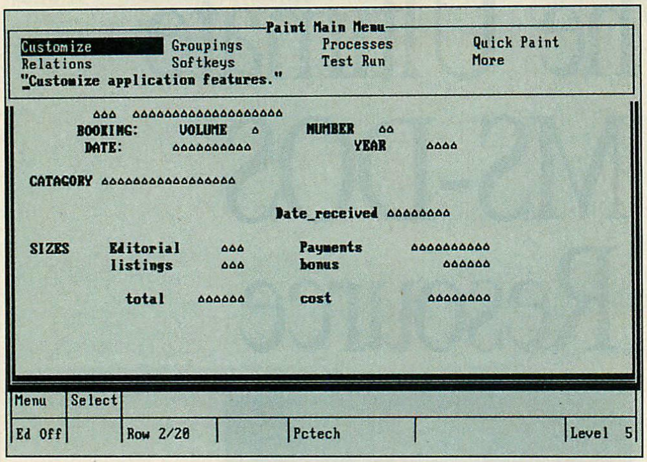
Advanced Revelation also includes a Processes menu that enables developers to control what happens before a screen is initialized, after it is finished and before it is saved, after it is saved, and so on. With each prompt in a window, the developer can specify that the system perform a unique function (such as showing a pop-up window or a help message) either preprompt or postprompt (just before the prompt is accessed or just after it is completed).

This approach allows developers to take control for a moment at virtually any point in the window process to modify the flow of data from user to database. In many cases, processes desired by window designers are already supplied by Advanced Revelation, so little hand-written code is needed.

Under Revelation G, a simple screen can be created quickly. If considerable multifile accesses are needed in the window or special processing required at a particular prompt, considerable knowledge of R/BASIC is a must to ensure that the variables are passed correctly. Screens can be linked, but only head to tail—that is, starting another screen after the first is done.

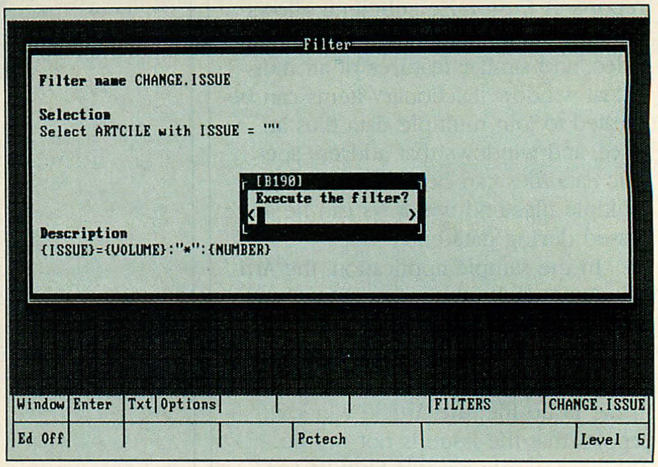
Advanced Revelation's screen generator can manipulate several files at once without using hand-written code. It can perform a file join during data

PHOTO 1: ***Painting a Window***



In the Paint main menu the highlighted selection is explained in quotes; the status window displays the editor mode, user name, and other information about the process.

PHOTO 2: ***Filters to Select Records***



This filter selects all article records with a valid issue number. Issue is defined as volume times the number. A filter requires only a few lines of code to manipulate the data.

entry at each prompt in the window. This is separate from any preprocessing or postprocessing performed at that point and typically replaces the most common type of hand-written subroutine used under Revelation G. It obviates the need for special code to simultaneously update a field in a related record to reflect a change in the current record. No indication necessarily is given on the screen that this change is happening because it is a background function of the window to synchronize related data files. If the controlling record is deleted, the window can be programmed to delete the relation in the other file automatically. Relating files and windows ensures a high degree of database integrity—a significant improvement over Revelation G, where the developer must code by hand to establish and remove relations.

Multivalue prompts. In windows displaying several sets of multivalue prompts, related prompts can be grouped. This allows developers to customize the prompts (make nested series, protect some from modification, allow several to be visible at once, and so on).

Once prompts are on screen in desired locations, the developer presses F10 to access the interactive paint assistance menu, then selects the Groupings option. A table appears in a pop-up where the developer enters grouping numbers to associate several prompts. The parameters in the Groupings table control the order and logic used by the system as prompts are selected on screen. The prompter stays within a designated group until a null is entered, indicating a desire to move to the next prompt or prompts.

When working with multivalued arrays, logical data structures must be given special attention. Special operators (+++, −−−, ***, ///) handle mathematical-array operations. Incorrect results could occur if single values are intermixed with multivalues because it is not possible within a multivalued set to multiply each succeeding value by a single value from elsewhere in the array. Instances exist when this limitation must be overcome. For example, in an order-entry application, a single discount rate must be applied against standard prices retrieved from the inventory file as each (multivalued) line item is entered.

The obstacle can be sidestepped by using a dummy field to hold a multivalued array, consisting of the desired single value repeated enough times to match elements of the array being built. Once the record is ready to file, a Postprocess subroutine can zero out the dummy field before storage, thus minimizing data redundancy while providing the needed structure for multivalued array processing. An entire subroutine can be written explicitly for this purpose, but is more work than a dummy field and harder to modify.

Filters. The company has chosen the generic term *filters* to describe the process of retrieving a subset of a file. A long-time strength of Revelation (and PICK-like systems) is that they can perform extensive ad hoc database searches independent of indexing or in-depth knowledge of the file structure; the user must know which dictionary items to request. Some database information is not stored anywhere but is computed when needed.

Filters streamline the process of building a command that *selects a specific* group of records for further processing. With interactive input in a menu format, filtering replaces the previous prompting mechanisms of Revelation G that required knowledge of R/BASIC or R/LIST. Collector windows prompt for data to drive the selection of records for a subsequent process.

At the heart of successful filter construction is a thorough understanding of the functions of dictionary definitions without which the selection process, however automated, cannot function. Constructing a filter still requires some knowledge of R/BASIC and formulas, but the alternative under Revelation G is to write a complete program. A filter requires only a few lines of code to manipulate the data records (see photo 2). Once the developer creates them, collector windows and filters for selecting records present a pleasant and logical user screen.

Because the Article file in the sample application stores the editorial-page and listing-page counts booked into an issue for an article, a dictionary item can be set up to compute their total. The dictionary item is created either with the system editor or from the Files menu. From the developer's or user's standpoint, this computed field is treated as a data item. Sorting, selecting against criteria, and listing of the file are transparent to the user. Advanced Revelation software, therefore, is written with an eye toward asking the system to find records meeting selection criteria and then performing a process on that subset. Advanced Revelation itself is perhaps the most highly devel-

oped example of how to modularize the different pieces of a big application and keep it under control.

Macros and keystroke capture. Macro building and keystroke capture are especially helpful features. Macros are constructed of codes for Advanced Revelation internal functions, such as menu, window, pop-up, subroutine; any number of desired macro sets can exist for a file. They are executed upon striking a key combination, such as Alt-F1 through Alt-F5. Starting any process can load a macro set or a macro can be specified to execute at log-on.

Keystroke capture is a sequence of keystrokes entered from the keyboard to create application demos or log all activity during a session. The captured-keystroke file can be edited and commentary inserted during playback. Keystroke capture can be toggled on and off; both keystroke capture and macro execution can be controlled by settings in the Environment menu.

When keystroke capture is used to log activity, the resulting file, which contain all errors in addition to new entries, can be used to restore the database. Another recovery strategy takes advantage of the ability under the Processes menu to replace the system's write-a-record function to keep whole transactions in separate files. This is done by creating an additional set of the files that must be reproduced on a separate volume or disk. In collector windows, a developer can replace the Advanced Revelation write-a-file routine with another that writes not only the current record in the (normal) current file, but also a copy in the transaction file. The backup routine is invoked with the SUSPEND statement to clear the transaction files after each backup. Anytime after a crash, users can restore master files from the last backup, copy the transaction files, and overwrite the master files with the most recent copy of the affected records. This is most effective using a separate disk drive.

VALUABLE MISCELLANY

Advanced Revelation is delivered on 10 diskettes and requires at least 512KB of memory. A 640KB machine, however, can have problems if it has many terminate-and-stay-resident programs such as Borland's SideKick and SuperKey loaded, which could limit remaining memory for manipulating files. Because Advanced Revelation manages its own file space (like a virtual system), more disk activity occurs as files are written out to disk from memory and available memory buffers are used.

Advanced Revelation is fast during normal operations, but on machines less powerful than an AT, wait states occur as windows change. Waiting for the system to catch up on an XT can be inconvenient and frustrating, especially when a developer makes a mistake (for example, selecting the wrong menu option) and must wait to quit an unwanted menu and access the another. During testing, repeatedly pressing Esc or the arrow keys while waiting for windows to appear caused Advanced Revelation to go out of control. A 10- to 20-second wait was necessary while Advanced Revelation cleared the terminal buffer and overran the desired menu. The problem was avoided by moving the application from an XT compatible to a 10-MHz 286 machine.

While PICK and Revelation G typically accept only uppercase characters, Advanced Revelation takes lowercase ones as well. It also provides terminal support to other computers (usually mainframes or minicomputers). No particular terminal is emulated, and no facilities are provided to send or receive files. The utilities provided with Revelation G work well in this regard. Although their counterparts are not present in Advanced Revelation, they easily can be added by developers.

The status window. At the bottom of the screen, if not suppressed, Advanced Revelation displays a status window, indicating what the system is doing or the features in effect. The left side names the current process (for example, menu, editor, or pop-up), below which the status line displays filters in effect, current row position, and total rows defined for the window. On the right is a macro indicator with the name of the current macro set, if any. The current user name is displayed (helpful for users who forget how they logged in), as is a window indicating active background processes, such as indexing and current nested level.

Advanced Revelation uses the upper-right portion of the status window to issue immediate messages about the process currently underway. At log-on, the user begins to navigate through a hierarchy of menus and windows. The system state is saved, so that when the user presses Esc to exit the current process, the system can restore the previous system state. The overhead involved in keeping track of so many possibilities does not slow down Advanced Revelation. The status line can be suppressed by the current window, but is especially useful to developers to track system activity anytime.

Batch processes. Even in realtime systems, batch processes are needed to coordinate updates of certain files when the system is quiet or when access can be restricted to ensure integrity of the database. Because Revelation G lacked batch processing, hand-written code was required to include a batch process for a simple process such as reading a record, performing a minor calculation, storing a new value, or advancing a record. Advanced Revelation provides a batch processor that is somewhat cumbersome but can perform batch updates without writing code. When a batch process is run, affected records are modified and stored in a temporary transaction file.

The batch processor involves building and executing a batch process, producing a comparison report showing what the changes will be as a result of the batch process, and making the changes permanent by integrating the changed records into the original file and clearing the transaction file. The developer creates a batch process specifying which records to use, fields to change, and formula to use for modifying the existing field. The batch process then can be run anytime and automated with macro keys or menus. Custom code often outperforms the Advanced Revelation batch processor because custom code is task specific.

Import/export. Advanced Revelation's data-transfer facilities (all on the menu) are far more extensive than Revelation G's. Advanced Revelation directly can import or export dBASE, ASCII, Revelation G files, and Lotus 1-2-3 and compatible files directly from the worksheet record. The ASCII import procedure involves assigning each field, in order, to existing dictionary fields in an Advanced Revelation file, or building the dictionary as it goes. The dBASE import process reads the dBASE file header to determine the appropriate field types to perform conversions, such as changing dates from the external format of dBASE to the internal format used by Advanced Revelation. If the file in Advanced Revelation is set up first and uses cross-referenced indexes, time for importing is increased because the system is trying to resize files and update indexes at the same time that it is loading new data.

Networking. Revelation has focused on networking for many years and Advanced Revelation follows that tradition. The company is making drivers for all common networks available. Enhancements to Advanced Revelation make it function better in a network environment than Revelation G did. A future article will describe in detail Advanced Revelation's multiuser functions.

Printing problems. One annoying quirk still present in Advanced Revelation is poor recovery from printer errors. A simple spooler utility called PDISK transfers files to disk and lets the system print them as a background task. If the spooler is not invoked first and no printer is found for the print job, Advanced Revelation halts with the dreaded "Abort, Retry, Ignore, Fail?" message. This is a minor problem if the printer is off-line. It is more than annoying when you are demonstrating software on a portable to which no printer is attached and an inadvertent print job is started. It is difficult to explain to your audience why Ctrl-Alt-Del is needed to clear that message.

DELIVERING UNDER FIRE

Creating the sample application using Advanced Revelation was smooth. Displaying author information in the author window and then requesting all related articles represents the one-to-many relationship. A file can be constructed to contain (by author number) the article keys of all his or her works. Each time an article is added or the author number is changed in an article record, the relational index file is automatically updated. Then the relational file can be joined to the Articles file to find the list of articles.

The Authors file could be used as the relational-index file by first defining a field in the Authors file to contain the list of articles written by that author, then pointing the relational-index instructions to that field from the article window. When the author's record is read, the program already has the list of keys to the Articles file. This approach is best if the number of articles per author is small (30 to 50). With a larger one-to-many relationship, reading in the key list, whether or not it is needed, increases the overhead needed to read and process records.

If the author field in the Articles file is multivalued, the only way to handle a many-to-many relationship is by using a postprocess routine. As the record is filed, a subroutine is called to update the Authors file and other needed files on a record-by-record basis whenever the Articles file is updated.

Reports, forms, and labels. The typical report produced by Advanced Revelation is a columnar report driven by the dictionary items of the file used. R/LIST is nonprocedural as long as some simple rules are followed: the first word of

a sentence must be a verb such as List, Sort, or Select followed by the file name upon which to act. The user then specifies any number of WITH, BY, AND, and OR clauses to limit the selection. Key words in the sentence are added for headings, footings, totals, subtotals, formatting options, and a list of dictionary fields in the order in which they are to appear in the report.

The following sentence was used to generate a list of articles that missed the deadline for a given issue:

```
LIST ARTICLE WITH VOLUME =?
  "VOLUME :"? AND WITH NUMBER = ?"
NUMBER : "? AND WITH
  DEADLINE.MISSED
  VOLUME NUMBER ARTICLE TITLE
AUTHOR.NAME DATE RECEIVED
DEADLINE HEADING "LIST OF ARTICLES
  WHICH MISSED THE DEADLINE
PAGE 'PPL' PRINTED 'TL'"
```

DEADLINE.MISSED is a symbolic dictionary item that returns true if the date received is greater than the deadline date from the issue file, and the constructs ?"**VOLUME** :"? and "?**NUMBER** : "? are prompts to input the volume and number desired. The report finds all matching records and prints out the volume, number, article code, title, author's name, and two dates. A **DEADLINE HEADING** says "**LIST OF ARTICLES** . . . " with a page number (the **PP** code) right-justified on four spaces. The **L** option forces a line feed, and the next line prints out the date, time, and another line feed before the body of the report is printed.

If the field being referenced is multivalued, the report normally shows all values in fields requested. This particular trait has been a bothersome problem with earlier Revelation versions: the report selects a record because one of the multiple values in a field matches the comparison operator, but the report prints all values found. New with Advanced Revelation is multivalue print limiting, which can scan the values in a field and display only those meeting the Limit phrase in the sentence. It is no longer necessary to define the file structure differently or write an R/BASIC program to do the report to get around this problem.

Forms are a type of report used when data do not lend themselves to columnar reporting, which is restricted to the width of a page in a line-by-line format. Although a Forms options existed in Revelation G, it was not nearly so capable as the new one. Two important qualities of the new Forms report are that developers create it like a data-entry window using the screen painter, and any field (symbolic or real) can be printed anywhere on the virtual form space.

A form can print anything for which a dictionary item can be developed. If a data-entry window has already been created to input the data, the developer can create an executable report simply by copying the window record from the Templates file to the Reports file, calling it up in design mode, and filling in form-parameter information. This includes number of records across and down the page, whether the record order is across or down the page, margins, headings, and footings. Forms are perfect for reporting output such as an invoice with multiple lines for each item ordered (from a multivalue field in the invoices file), a total line, and literals such as "Thanks for your business."

As handy as the copy-a-window feature is, the reverse feature could be more important if used properly. Just

as creating a window in Autobind mode will build dictionary items as the window develops, so will a form. This means that reports can be created first, letting the forms builder enter dictionary items appropriately. The developer can then define the data-entry screens, refine the system with cross references or other indexes, and print the output.

Labels can be produced as an extension of the report process by entering dictionary names to be printed in brackets (such as **last.name**). Literals, such as a comma between **city** and **state**, can be typed on the screen. The label processor does not have a Test Run feature, but printing labels is simple. Fortunately, the Label report process does not issue a form feed at the start as report processes often do.

Benchmarks. Benchmarks performed for this review were importing an ASCII file into the author file, creating an index on the author database, counting the occurrences on certain state codes in the author file, changing one state code to another in a selected group of records, and extracting a set of records from the author file and exporting a DOS file with this information. Although Advanced Revelation shows somewhat better performance than Revelation G, the benchmarks are not generally competitive with other, simpler data managers (see table 2). For data import and export, a custom program still outperforms the utilities provided. But because they are easily used and work reliably, the utilities need only be replaced or improved if data import and export are major aspects of the particular application. The benchmark listed for importing a file was run on a fixed-size file with no indexing in place to provide an apples-to-apples comparison.

While the second benchmark was not applicable to Revelation G, Advanced Revelation has added extensive indexing features and performs favorably because automatic maintenance of existing indexes speeds file sorting.

TABLE 2: ***Benchmarks***

BENCHMARK TASK	TIME	AVERAGE TO DATE
Add 900 records to an empty database table	87	168
Index table on two fields (7 bytes)	136	53
Document and tally codes from one column	59	47
Mass change of one column (28 rows of 900)	34	20
Extract selected records to create a text file	50	12

All times are in seconds.

All benchmarks were run on an IBM PC/AT (6 MHz) with 640KB memory. The tests were run in an 8MB partition on a CMI 20MB hard disk under DOS 3.0.

Advanced Revelation benchmarks are generally not competitive with other, simpler data managers. Only when adding records to an empty database table did Advanced Revelation show a marked improvement over the average times.

PLANNING PROTECTIONS

Developers have several options for controlling user privileges under Advanced Revelation. These include defining the log-on procedure; assigning passwords to users, accounts, and windows; and assigning restriction levels to windows in accounts. A menu for establishing LOGON accounts and user names is available from the system programmer (SYSPROG); users can be granted access by logging on with either a user or an account name.

Revelation Technologies recommends that each application be in its own account with its own security restrictions. Users can then be defined for the account, with each user having different environment settings, video settings, and security-restriction levels. Establishing the log-on name as an account gives the user access to a logical group of files separate from other users on the system. The total disk space is the only limiting factor to the number of accounts that can be entered on the system. A given account can access different sets of files (at different times, of course) by attaching a volume, which is a distinct set of files (often a subdirectory).

Files can be named the same on different volumes, with the most recently attached taking precedence. Picture, for example, three separate sets of payroll files for three divisions, kept in separate DOS subdirectories. With the SETVOLUME command, the groups of files can be given a meaningful name. The command ATTACH ADMIN would replace the Employee Master file currently in use with the Employee Master file from the ADMIN volume, but would retain the program files that operate on that data.

Logging in as a user permits access to the same group of files as other users on the same account, but with a unique set of environment parameters. Two users in a payroll department could access payroll files: one able to update information and view all reports, the other restricted to viewing only certain files. This is accomplished by an extensive series of security levels and restrictions set up in the environment record and in the Secure User section of the system Management menu. Each user (and each account) receives a password that (unlike Revelation G) is encrypted on the system. The log-on environment specifies a process to be executed when that user starts up, and can specify a process that executes at restart, if for some reason (such as a basic program problem) the user winds up in the debugger.

Privilege levels 0 through 5 can be specified for each window, with level 5 being most restrictive. Each window can be assigned an access level in the window-definition record that is compared with the established privilege level. This allows several users to see the same menu, but only users having the appropriate privilege level would be able to run a particular window. With some thought, developers can set up extensive security.

Advanced Revelation's plethora of features confidently and flexibly secures the system by allowing security levels to be defined on a process-by-process basis. It also does not face the same dilemma as systems that forsake good security for fear of restricting user accessibility.

ENRICHING THE RECIPE

Revelation documentation is like a chocolate cake that grows richer each time it is made—those adding the ingredients cannot resist adding in more chocolate to make it all the more tempting. Advanced Revelation's documentation succeeds in spicing up illustrations of the philosophy behind system design that is helpful for designing complex operations.

By using the batch processor and a filter to select records and change some fields around, redefine some dictionary items, and allow the system to update indexes, developers can perform operations as fundamental as restructuring a file and associated indexes without writing any code.

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ZANTHE

Designed With Professional Developers In Mind!

CIRCLE NO. 237 ON READER SERVICE CARD

Advanced Revelation has several features designed to ease application development. For example, a developer can create a needed dictionary item by pressing Shift-F10 midstream while creating an entry screen. Likewise, partially through a complex screen, a developer can press F10 and select Test Run from the menu to see if progress is on track. The system saves the screen and loads and runs it as is; the developer presses Esc to return to design mode. At almost any point in the Design/Window/Paint mode, pressing F2 displays available responses or choices that can be selected with a function key. Alas, tutorials to demonstrate even more tricks and tools would go a long way toward further beefing up documentation and sharpening the use of tools for application development.

Advanced Revelation's imperfections in its otherwise excellent documentation involve poor subject indexing and several unhelpful, although technically correct, internal system messages. For example, while converting the sample application, 30 minutes were wasted trying to determine why the system said it was "Unable to create RDES on volume TECH." The reason turned out to be that the file already existed and therefore could not be created. A mere three or four pages of wisdom from the company explaining unclear messages would save the developer a lot of time (especially an Advanced Revelation neophyte).

Revelation Technologies provides comprehensive support. A new purchaser qualifies for six months of free access to a customer support hotline (not toll-free) and an Advanced Revelation newsletter. A $200 fee per year buys access to an extended-support hotline, presumably one of higher technical capabilities. For occasional support, a user can dial (without registration) a limited-support hotline for $2 per minute with a $20 minimum. The company periodically distributes booklets describing software available from some of more than 1,200 developers around the world, while user groups around the country dispense local product support. Third-party organizations also offer specialized training in the use of Revelation.

CONVERTING FROM VERSION G

Advanced Revelation is different enough from Revelation G that the company provides special software to import version-G applications into the Advanced Revelation environment. Not all programs will convert, the most conspicuous example being cross-reference logic, because the two products handle it so differently. However, files, data dictionaries, most menus, and entry programs migrate easily. The sample application used for the Revelation G review was converted in only three hours, with most of the time spent watching Advanced Revelation go through the files and rebuild them into the new filing structures. The application originally required 8 to 10 hours to create under Revelation G.

Revelation Technologies provides a special utility for combining version-G systems and Advanced Revelation-developed software when needed (such as when substantial specialized code was used under Revelation G). A G-Mode running under Advanced Revelation runs version-G applications as originally designed. Developers can still use R/DESIGN from version G prior to conversion; once the switch is made, all further development must be done in Advanced Revelation. Conversion to Advanced Revelation is expected to drag on. The agility allows a Revelation G application to be furnished under Advanced Revelation with new portions using Advanced Revelation features and older sections remaining in G mode pending rewrite.

Some aspects of the application reveal why rethinking an application's structure is worthwhile when converting from Revelation G. For example, the data layout affects which tools save time and most efficiently use Advanced Revelation's resources.

COMPLEX, NOT COMPLICATED

Because Revelation is an outgrowth of minicomputer, multiuser environments, its problem has never been an inherent lack of ability or purity of design but rather lack of front-end friendliness for people unfamiliar with relational databases, in general, or PICK-type operating systems in particular. Advanced Revelation cuts these criticisms to the quick and makes a better product for the AT environment.

Advanced Revelation makes headway for Revelation Technologies and for small relational database systems in general by introducing a sound user interface; few data-management experts will disagree.

What Advanced Revelation cannot do as well as Revelation G is provide a development environment that transports quickly to a PICK-based minicomputer or an AT. The new system no longer has facilities to generate a basic program that can be adapted to other PICK systems. This creates a problem for in-house software departments interfacing to a minicomputer.

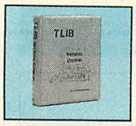
Discounting this drawback and assuming sufficient AT horsepower, Advanced Revelation is a satisfying tool to use and lets developers produce an extensive application in a short period of time with some familiarity. Runtime versions are available and network support is well proven. Rather than being just another refinement of an older system, Advanced Revelation might well represent the beginning of a new class of application development tools.

Its own tools, used to build Advanced Revelation, are hallmarks of the product. Help windows such as those used to create pop-ups are themselves created using Paint. The menus that guide developers through application creation are concocted with the same tools used in the application. In this sense, Advanced Revelation is its own best example of what a finished application can look like.

Kent Phelps has many years experience with PICK, PRIME information, and Revelation systems, and is currently head of COMMUNI-CONSULTANTS, a software development company specializing in Revelation-to-PICK conversion tools and systems.

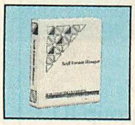
PRODUCT WATCH

Reviews and Updates



TLIB 4.02
Burton Systems Software

SMART LAN PERFORMANCE TEST
Innovative Software Inc.

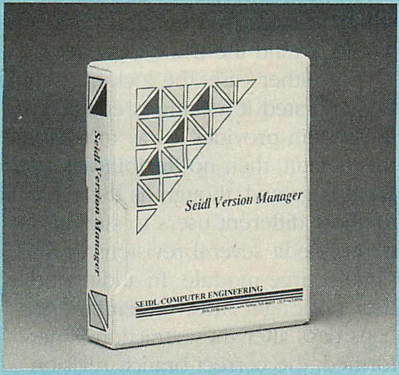


SEIDL VERSION MANAGER 2.0
Seidl Computer Engineering

NETMANAGER
Brightwork Software

SEIDL VERSION MANAGER 2.0
Seidl Computer Engineering
3106 Hilltop Drive
Ann Arbor, MI 48103
313/662-8086

PRICE: $299.95

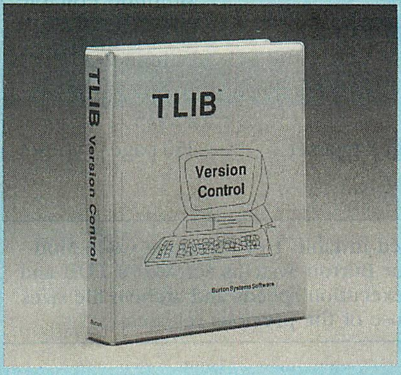


CIRCLE 332 ON READER SERVICE CARD

TLIB 4.02
Burton Systems Software
P.O. Box 4156
Cary, NC 27511-4156
919/469-3068

PRICE: $99.95

UPDATE



CIRCLE 331 ON READER SERVICE CARD

A source code management system (SCMS) creates a record tracking the changes made in source code modules and other project documents. By saving only information contained in the base file as well as information that describes the differences between each revision in an archive file, disk space is saved compared with storing the full contents of each revision. Modifications are tracked with a time/date stamp of the update, the name of the person performing it, and perhaps a short comment describing the reasons for the update. Better SCMSs lock files in use to prevent more than one person from making changes to the same modules.

The features of six SCMSs were described in "Tracking Code Modules" (Jim Vallino, September 1987, p. 50). Since that review, two of the programs, Burton Systems Software's TLIB Version Control and Seidl Computer Engineering's Seidl Version Manager (SVM), have been revised. This update concentrates on the features added in TLIB 4.02 and SVM 2.0. For both products, the new features did not hinder speed of execution or increase the size of the archive file.

Burton Systems. The original review found TLIB to be one of the better SCMSs. Version 4.02 adds multiline revision comments, support for branches, and key words. The usefulness of some features is limited, however, by the way in which they are implemented.

TLIB prompts the user for a comment to describe the revision whenever a file is updated. The system allows for line editing of the comment while it is entered. With version 4.02, multiline comments can be entered by placing, on all but the last comment line, a backslash (\) as the final character before the Enter key is pressed. Once Enter is pressed, the line just entered cannot be edited—which is a cause for some frustration.

Similarly, several of the systems reviewed last September allow editing only on comments as they are entered. From the user's standpoint, a more convenient SCMS implementation would allow the execution of a copy of the user's preferred editor for entering comments. If none is specified, then the SCMS could default to the internal line-editing method. The only drawback to using an external editor is the delay while waiting for the editor to start. TLIB allows its users to configure most of its features; the ability to call an external editor as a configurable option would leave the decision of speed versus ease of editing to the user.

Branches in revision paths are useful on software projects with several parallel development paths. For example, branches could help developers customize programs for individual clients or port their software to different operating systems. TLIB supports revision numbers with up to nine imbedded periods—meaning that it supports up to nine levels of branching. Each branch adds another period and an integer to the complete revision number.

Adding branches to TLIB causes a problem with the mechanism used for locking files. In previous versions of TLIB, which supported only a single development path, it did not matter that the archive file was locked when a developer was editing a module. With branches allowing simultaneous development along different paths in an archive file, the proper method is to consider that a revision is locked for edit, not the archive file. Each locked revision would be checked out to a different project member. TLIB allows only one user to have a lock on an archive.

As a further inconvenience to the user, this lock can be generated automatically only when the latest revision on the trunk is extracted. Returning to a previous revision, with the intent to work on a new or existing branch, does not create the edit lock. Instead, the user must manually lock the ar-

TABLE: ***SCMS Features***

	BURTON	SEIDL
Product	TLIB	SVM
Version	4.02	2.0
Price	$99.95	$299.95
Specific directory structure	○	○
Revision locking	Optional	Optional
User identification	●	●, also group ID
Revision deletion	○	●
Symbolic version labeling	Batch file	●
Branching	●	●
Merging	●	●
Key words	●	○
Difference program	●	●
Activity logging	○	○
Screen-based interface	●	●
User configurable	●	●
Archive file write-protected	Optional	●
Archive file name	Extension calculated	Work file
Revision comments	Multiline	Multiline, editable
Work file time/date stamp	Original, current	Original
Maximum line length (char.)	254	Unlimited
Maximum number of lines	32,000	16,383
Maximum number of revisions	32,767	65,535
Manual size, style	134 pages, typeset	250 pages, typeset

● = *Yes* ○ = *No*

This is an update of the features that are listed in table 1 of "Tracking Code Modules" (Jim Vallino, September 1987, p. 61) for Burton Systems Software's TLIB and for Seidl Computer Engineering's SVM. The execution speeds and archive file sizes of both packages remain unchanged from those of the previous releases.

chive after getting the desired revision of the source module.

If another user then does a normal extraction to get the latest trunk revision for editing, TLIB displays a message that the lock file was created when, in fact, the original locking information is intact. Only when this second user attempts to update such a changed file does he learn that someone else has a lock on the archive. In practice, therefore, only one person can effectively work on a project at a time, even though up to nine different development paths can be created.

When an archive is edit locked, anyone can get a copy of any revisions in the archive with the B (extract for Browse) command. This at least allows an entire system to be built while development continues on revisions. The system of locks introduced by TLIB severely limits its usefulness on a complicated development project which requires branch revisions. The locks will function as in the previous release, if branches are not used.

The system does not maintain any information about the revision which a user has checked out, so that when changes are completed, the user must remember whether a trunk or branch revision was made. (The expansion of the system's key words, described below, can aid the user here.) The U (Update) or K (update and Keep locked) commands are used to check in trunk revisions while the A (Add branch) or M (Make branch and keep checked out) commands are used for branch revisions. It would be very easy for the user to mistakenly use the more common U command to check in changes that should be on a branch. Undoing this mistake is not easy because TLIB does not provide a command to delete revisions from an archive.

Assuming that the user remembers to check in a branch revision, the system also requires information about which branch to update. A list of revision information is displayed for all revisions in the archive to aid the user in selecting the proper branch to update. The revisions are listed in time sequence of creation (from the oldest revision to the newest one), which can be difficult to interpret when an archive has undergone many revisions and branches. A configuration option to specify a listing of revisions in breadth-first or depth-first order would be convenient here. Requiring the user to remember the revision number information is only inviting error.

TLIB already provides different commands for getting the latest trunk revision with edit permission, E (Extract), and without, B (extract for Browse). These commands should be extended to handle previous revisions on any branches as well. TLIB should maintain information about which revision a user has checked out for edit. With that information, the U command could determine which revision to create when the user checks in the changed module. The system can also assume that an extraction on anything other than a tip revision means that the user plans to create a new branch, while an extraction on a tip revision would extend the trunk or root.

In either case, the lock file should be generated if locking is enabled. If the system provides a way to override this default, then no flexibility is lost. What is gained, though, is the capability to allow different users to simultaneously edit several revisions of the same source module. In addition, the user no longer must remember, perhaps days after the extraction is performed, the correct branch revision number for the modified source file.

The addition of key words to TLIB helps developers trying to determine which revision of a module is in view. The method used to specify the location for the inclusion of the key words in the extracted source file trades quicker extraction times for a slightly cumbersome syntax. The user must indicate the exact column in which the key-word specifier will exist in the extracted source file. This is done with the new KeyFlag configuration option. The key words are actually expanded on the next line of the source file between specified delimiters. Suggestions are made for KeyFlag choices for the popular programming languages. Three key words are recognized: revision number, revision date/time, and identification of the user who checked in the revision. These three key words are sufficient for most project needs.

TLIB substitutes key words in place so that, once the key words are inserted into a source file, they do not have to be edited again. The system will maintain correct key word substitution across all subsequent operations

on the archive. One problem was found with the key word operations. When the K or M (Make branch and keep checked out) commands are executed, a file is checked in and out again in a single step. In the interest of saving time, the work file is left in place without expanding the key words again. This feature results in the work file having the key words expanded for the previous revision. As a side note, the problem with the DeleteSrc and the K command interacting to cause the work file to be removed (reported in the September 1987 review) has been fixed in version 4.02.

TLIB now comes with LISTBLD, a utility program that can analyze a program source file and generate a list of all included files. LISTBLD searches for the appropriate include statement for the language being used and, optionally, will recursively search all files that are included. The list it generates is used with TLIB'S TLIBSNAP program to generate a BAT file—which will extract the correct revision of all files that make up a release of a program.

If any of the files that make up a version of the full program require a branch revision, then the user must manually enter this information for the LISTBLD program or edit the file generated by TLIBSNAP. Finally, TLIB's new configuration option, appropriately called OldDate, will cause all extracted files to be stamped with the time and date, indicating when the revision was originally checked in.

Seidl Computer Engineering. One of the first improvements noticed in version 2.0 of Seidl Version Manager (SVM) is the better arrangement of the manuals. Information is now organized and contained in four separate sections: *SVM Administrators Guide*, *SVM User's Manual*, *SVM Technical Reference Manual*, and *SVM Appendices*.

Each section aims at a different kind of user. The bulk of SVM users will need to read only the *SVM User's Manual*. This manual describes the hands-on demo, some basic concepts in source code management, and the menu interface (which can be used for almost all day-to-day activities). The *SVM Technical Reference Manual* gives some more detailed information about each program in the SVM package and lists all the command-line options. This description of the command-line interface is a great improvement.

As its name implies, the *SVM Administrators Manual* describes the operations to be performed by the administrator or by the source code librarian. The *SVM Appendices* section rounds out the documentation with information that applies to all the other manuals; it is conveniently placed in one location for easy reference.

Security-conscious developers will greatly appreciate SVM 2.0. In the process of adding user identification (ID) to SVM, Seidl has added several other stringent features to make source code management more secure.

A user must log into the system, optionally being required to enter a password, before performing any source code management operations. It would be helpful if the user ID could be specified using an environment variable. All other systems reviewed last September used environment variables or information in configuration files to provide this information; however, they do not provide the security afforded by SVM's optional password. The system administrator has the ability to create new users, delete old ones, or to indicate that their privileges have expired. Every user is assigned a four-digit number for a user ID, along with a user name. The first two digits of the user number represent the user's group.

Each file under the control of SVM can have up to three owners; moreover, different privileges can be specified for each owner's access to the file, as well as different access privileges for each owner's group.

The user who creates the archive is the first owner of the file. Seven access levels are available for users who neither own the file nor are in the same group as one of the owners. These access levels allow progressively more operations to be performed on the archive file. They range from NONE (allows no operations to be performed on the archive) to UNLIM (allows all operations, including deleting revisions). The levels in between permit updating the archive, viewing revisions in the archive, and seeing only the revision audit information.

These provisions, which are the most comprehensive of all the systems reviewed, will control programmers' access to the information in the archives and help prevent unauthorized updates to a project's source-code modules. The security provided by the user ID/password and access levels can be breached, however, because the archive files are maintained unencrypted by SVM and anyone on the system can read the source information contained in the file. This issue, however, involves operating systems as much as it does source code management.

The system administrator must define a unique user number and ID for everyone who will work with SVM. Because of omissions in the documentation, the first trick for the user of a new system is to log in as the system administrator. The installation procedure for a Single Site SVM neglects to mention that the environment variable SVMADMIN must be set (either from the DOS command line or in a batch file). The installation instructions say it must be done for Network SVM and it is implied in the appendices to cover Single Site SVM as well.

Once SVMLOG can find its administration files, the user then discovers that the password for the Admin user is not given in the manual. The same is true for Superowner, the other predefined user with special powers. Fortunately, it only took a couple of tries to discover that the passwords are the same as the user names. Either these predefined users should have empty passwords when the system is shipped, or this password information should be the first item in the manual.

SVM's menu system would be improved if it displayed the name of the current user (perhaps near the project name). A command is available from the DOS command line to list all users who are logged in (multiple users could be logged into the system with Network SVM), although no indication is given regarding which user is the one logged in on the local machine. Logging in and out of SVM is treated as a separate activity from the use of the SVM interface menu. This separation, no doubt, will cause problems: if users forget to log out after their work is done, they will leave the system open to access by anyone else who may subsequently use the machine.

A better implementation would make logging in a required activity whenever the menu interface is begun; and then the user would be logged out automatically when exiting from the SVM menu. Thus, for the majority of users, interaction would be entirely through the menu shell.

SVM has added the capability to lock an archive file with the incorporation of the user ID. This lock suffers the same problem as TLIB's—the entire archive is locked, not just the revision being edited. The problem is even worse under SVM because the file is locked for all operations by any user until the lock has been removed. The owner of the lock can cause it to be removed when the file is subsequently checked in, or the special Superowner can run an administrative program to unlock the file. While the file is locked no one can get a copy of any revision in the archive. This effectively prevents parallel development by several programmers because, in order to build a working version of the program, previous revisions of the source files must be available to any project member. Edit locks, as they are currently implemented in SVM, are not usable.

SVM version 2.0 has a new feature—the removal of the fixed-directory structure—that makes it much easier to configure for multiple projects and programmers. In the previous version, three directories, \BASE, \ARCH, and \WORK, had to exist in a project directory. The user was required to move back and forth between the project directory and the \WORK directory

to perform normal source code management and development activities.

In version 2.0, the user defines the structure for different projects. Part of this definition is naming all the directories where the archive, base, and work files should be kept. When a user logs into SVM, the current directory is used as the name of the project. The most natural approach defines this directory as the \WORK directory also. This process causes the work files to be placed there when they are retrieved from the archive.

SVM provides a mechanism to change projects from within the menu interface. A couple of problems were found in the documentation related to defining a new project. Contrary to what is stated in the manual, it is not possible to leave the \WORK directory field blank to instruct SVM to place work files in the current directory. When this is done an error message, "S21: Bad project configuration," is displayed. No more information is available from SVMHELP, SVM's on-line help system, to describe a possible solution. (Moreover, SVM's menu system lacks access to the on-line help information. Currently, it is available only from the DOS command line.)

The solution is to provide the full path to the work directory desired. In addition, the manual does not explain fully how to use a RAM disk for the \BASE directory. The manual suggests the \BASE directory be placed on a RAM disk to improve execution times when making revisions to the archives. It is not possible, however, to place these files in the root directory of a RAM disk because DOS treats the root directory and subdirectories differently. The \BASE directory must be declared as a subdirectory. This is a minor inconvenience because RAM disks are empty when installed and the user must ensure that the directory specified for the base is created on the RAM disk before SVM is used.

Other features have been added with version 4.0. Users can now delete a revision from the archive file. The revision specified—and all descendant revisions—are deleted. Because this can have catastrophic consequences, SVM generates a warning indicating how many revisions will be deleted before continuing. Also, the user must have UNLIM access-level permissions to perform a revision deletion.

The utility DSAPP can read delta-scripts and create a new revision of a source file. The delta-scripts, which are generated as an option when a file is checked in, describe all the differences between the two revisions in the archive file. This much smaller amount of information can then be transmitted to a remote machine to update the archive files using DSAPP.

SVM now also provides a capability to merge two modified files. This situation might occur when two programmers simultaneously make changes to one file, which then must be combined into a single revision of the file.

INTELLIGENT CHOICES

TLIB and SVM are two good SCMSs. Both have been updated with helpful new features. Their only major problem is the way in which both systems implement locking. Unfortunately, revision locking is an essential aspect of source code management, especially on complicated projects that involve many programmers.

Burton's TLIB is a great system, particularly when you consider its low price (under $100). All of the features

that were deemed to be missing from the version reviewed last September have been added to TLIB 4.02.

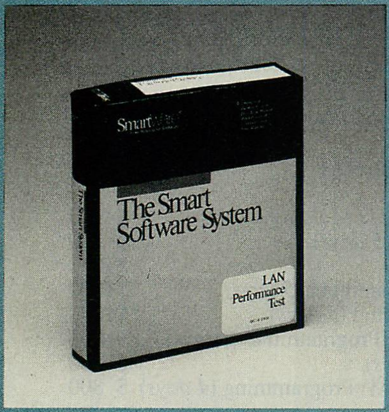
Seidl's SVM 2.0 is the system of choice for anyone who has the responsibilities of a LAN administrator or software librarian. The addition of both user and group IDs—along with password protection and varying access level permissions—makes SVM the most security-conscious system available. For smaller shops this might be excessive, but for others this level of protection is just what is needed, especially if many projects use SVM on a networked file server. In terms of features, SVM really only lacks key words, which Seidl plans for the next release.

—JIM VALLINO

SMART LAN PERFORMANCE TEST

Innovative Software Inc.
9875 Widmer Road
Lenexa, KS 66215
800/438-7627; 913/492-3800

PRICE: $49.95



CIRCLE 333 ON READER SERVICE CARD

Innovative Software's Smart LAN Performance Test (LPT) presents a unique angle on LAN testing, because it combines application simulation with an iterative file-server access metric. Most LAN benchmarks are based solely on low-level operations, such as disk reads and writes or repeated record locks and unlocks. These low-level tests help determine levels of workstation throughput in a laboratory setting, and the results are usually stated in kilobytes per second. The problem with the kilobyte-per-second metric is that real-world applications rarely place a continuous, unchanging load on the server and thus are more complicated to model.

The Smart LPT benchmarks are more meaningful than low-level LAN benchmarks because they simulate the influences of end users and application software on LAN performance. Simulation during Smart LPT's performance testing is achieved with the Smart Software System, another Innovative Software product. This software consists of five tightly integrated LAN applications including word processing, spreadsheets, multiuser database, communications, and desktop utilities.

These integrated applications are optimized for the LAN environment, and they have a consistent user interface that is function-key and menu driven. Another feature of this integrated application suite is the Smart Programming Language, which can automate functions in or between Smart applications. The Smart LPT is written in the Smart Programming Language.

THE USER WORKSTATION

Smart LPT has three primary functions that can be selected from the product's main menu. These functions conduct application simulations, benchmarking, and reporting. The User-Workstation function simulates applications and can run on up to 1,000 workstations. It provides selections for database, word-processing, spreadsheet, or integrated modes. The integrated mode combines the other modes to simulate a LAN user who is alternating between word processing, spreadsheet, and database processing in a windowing environment. All modes have three usage-level settings—light, medium, and heavy—that specify what amount of network loading the workstation simulates. Medium usage generates twice the network load of light usage; heavy usage is twice that of medium usage.

Combining the four application modes and the three usage levels opens up the full gamut of simulation possibilities. For example, a heavy-usage database simulation places substantial I/O demands on the network with record locking, queries, and updates. Conversely, a low-usage word-processing simulation spends most of its time on local manipulation of documents; this combination puts little demand on the network.

THE CONTROL STATION

Smart LPT's second function is the Control Test Workstation, which is activated on a LAN workstation with a printer and local drive to record the test results. Before the control station is activated, all other stations involved in the test are started in the user-workstation simulation. These simulations create a backdrop of random LAN traffic against which the control workstation's iterative benchmark is run.

The control-station benchmark is a database routine that accesses a temporary database file on the file server. This database comprises 50 records, and the benchmark routine times itself while writing to each record sequentially. This process is repeated seven times for each test run. A test session then repeats the test run five times, recording in seconds the time elapsed for each test run. After the test session is completed, these five run times are averaged to produce a composite figure. The test results are recorded on a diskette at the control workstation, and they can also be printed out.

A test-session result (the averaged test-run figure) measures performance for a specific LAN configuration. This measurement can be used to compare the relative performance of other LAN configurations running the same benchmark. Such a comparison is accomplished by running the test sequence, changing the LAN configuration, and then running the test sequence again. Elements of a configuration that could change between performance tests include the network operating-system parameters, file-server throughput, workstation throughput, number of workstations, and cable system.

Smart LPT's three application simulations—spreadsheet, database, and word processing—running on the user workstation can be modified between the test sessions, and the benchmark times will reflect the impact of the different types of software.

BENCHMARK REPORTING

To help interpret the complex test results, Smart LPT has a reporting function. This program makes use of the Smart Software System's spreadsheet module to output tables and graphs that are produced from the test data. The reporting program consists of two sections: the individual-report section and the consolidated-report section.

Individual test-run results can be viewed as spreadsheets that detail the times for each of the five runs, the average runtime, which application simulations were run during the test session, and other data that the user can enter to the spreadsheet. Graphs based on test data can be either viewed or output to a local printer or plotter.

The consolidated reports compare average test figures from a number of

different test sessions. One report plots the number of stations on the x axis and the performance factor derived from the averaged test times on the y axis (execution time versus number of stations). The consolidated-reporting feature also generates other reports that display performance for different network configurations in bar-graph form as well as cost comparisons.

Some of the reports use a baseline test figure obtained by running the control-station benchmark on a single network workstation, with no load on the network, or on a stand-alone computer. The baseline test figure given by Innovative Software for a stand-alone IBM PC/XT is 97.4 seconds. The baseline figure generated on a *PC Tech Journal* test network, with an AST Premium 286 and no other stations running, was 55 seconds.

In our evaluation of Smart LPT, the test network was configured first with one station, then with two, four, and six stations. The stations were 80286 and 80386 PCs, with a 386 file server running Novell Advanced NetWare 2.0A on an IBM Token-Ring topology. The user workstations simulated medium usage of an integrated network application, alternating between word-processing, spreadsheet, and database operations. The times elapsed for the baseline test (one station) and for the three test sessions were as follows: one station, 55 seconds; two stations, 55.6 seconds; four stations, 56.6 seconds; and six stations, 58.2 seconds.

It is reasonable to conclude that, because of the high-throughput characteristics of the network components, adding workstations only marginally reduced performance.

Smart LPT gives a better evaluation of LAN configurations than tests based only on continuous disk access. Because Smart LPT user workstations simulate actual network applications while the control station runs its benchmark, comparisons with real-world LAN environments are possible.

The ideal LAN benchmark for many LAN evaluations is to measure the time taken to perform standard end-user operations using actual network application software. Smart LPT, however, cannot do this type of benchmarking. Examples of standard application software operations are loading application files from the file server, reindexing databases, and checking the spelling of large documents.

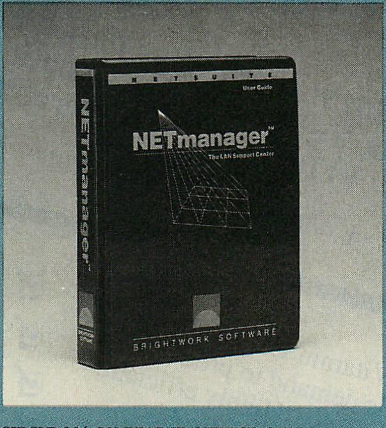
Despite their usefulness, Smart LPT test results do not represent the actual execution times of network applications. Instead they serve only as measures of relative performance. The ideal LAN benchmark system probably has not been developed yet; until then, Smart LPT is a practical solution.

—STEVEN S. KING

NETMANAGER

Brightwork Software
P.O. Box 8728
Red Bank, NJ 07701
201/542-7178

PRICE: $1,495



CIRCLE 334 ON READER SERVICE CARD

As the size of PC LANs grow, network administrators are being forced to take up long-distance running or find tools to support their networks from central locations. NETmanager, from Brightwork Software, can be used to establish a LAN *help desk*, where administrators can monitor other stations and assist network users.

The package also includes several databases that can provide LAN administrators with information about users, equipment, and trouble calls.

NETmanager is similar to remote-access programs such as Carbon Copy or Close-Up, except that it does not dial out to an external computer—monitoring is done through the network. For other stations to be monitored, they must first load a terminate-and-stay-resident *listening* program called NRLISTEN. This can be done with an AUTOEXEC.BAT file or through a network login script.

From their workstations, administrators invoke the NETMAN program from the DOS command line. The first option listed on the NETMAN menu is to "Control another PC" for remote support. After an administrator selects this option, a list of users logged on to the network appears on the screen. To start monitoring a remote PC, the administrator highlights a user's name with the cursor keys and presses Enter.

Once monitoring is started, the administrator's screen will display what is on the remote PC's screen. During help sessions, anything the administrator or the user types on the keyboard will appear on both the remote screen and the administrator's screen. At this point the administrator and user can address the user's problem.

The NRLISTEN program has several command-line options to disable or enable certain functions when the program is loaded. The remote-reboot option enables or prohibits the administrator from rebooting the remote PC. The keyboard-access option can prevent the administrator from using the remote keyboard. The password-protection option requires a password to start a help session. The notify option will sound a tone when an administrator takes over the workstation. The NRLISTEN program requires 9KB to 30KB, depending on which command-line options are chosen.

During the help session, NETmanager's on-line functions can be accessed conveniently with the Active Call menu, which is displayed by pressing the F1 key. The menu includes options for rebooting the remote PC and for viewing or editing the user and equipment databases.

The "Hang up and log trouble" selection from this menu ends the session and allows the administrator to log the support call. When a support call is logged in, the log-call screen represents a record in a database of *trouble tickets*. The fields of this screen include the type of problem, who took the trouble call, status of problem, and a free-form note field for additional information. The call also can be disconnected without logging a trouble ticket.

During a help session, a realtime clock records the time taken on the call and enters it automatically into the trouble ticket. This record, combined with the reporting functions of NETmanager, helps track problems on the network. In the process, it identifies users, PCs, and servers with higher incidences of problems.

Databases included with NETmanager keep track of users on the network and the equipment at their stations. The databases are stored in dBASE DBF format and can be used with dBASE to produce a broad range of reports in addition to those available through NETmanager.

The user database stores a variety of information about network users, such as names and addresses, telephone extensions, primary servers, departments, and user ID numbers. This database also includes the main applications they use, so that the LAN administrator can easily determine any user's software environment.

The equipment database details the hardware environment of each network user. Elements of the database include the type of PC, type of monitor, network adapter card (type and network address), video card, system memory, drives, and operating system version. This file can be extremely helpful, particularly when users do not know the configuration of their PCs and the only alternative is to open the system unit. Having such hardware information stored in NETmanager can save LAN administrators precious time.

Network administrators must create and maintain the user and equipment databases, which requires an extensive information-gathering exercise when NETmanager is installed. Administrators also are responsible for continual updates and for consistency of the NETmanager databases.

The configuration option from the NETmanager's main menu allows the administrator to change the application's configuration or to reindex or rebuild the databases. On the configuration screen, LAN administrators can change parameters for system defaults, such as path and file names for system files, and screen colors. In addition, administrators can specify here whether some entry screens will contain pop-up menus or blank fields. The configuration reindexing option repairs any corrupted index files, and the rebuild option removes deleted records.

NETmanager's reports come in several useful formats. Reports on trouble calls can be generated by problem type, user departments, server, or node. A Trouble-Ticket Detail Report lists trouble tickets consecutively. In one format, reports can be limited to a date range, so that administrators can review the current problems of their users. Another report lists users entered in the databases.

Reports are preceded by a report-generation screen that allows the administrator to specify criteria for the searches. The reports may be sent to the screen, the printer, or a file. The reports are well formatted, and they display the requested information in an organized manner.

NETmanager, unlike many network-specific utilities, supports both the Novell IPX interface and a NETBIOS interface. The package includes a distribution disk for each interface. With the NETBIOS interface, the range of networks NETmanager supports is broadened to include the IBM Network Program, Ungermann-Bass Net/One, 3Com 3Plus, AT&T StarLAN, and other NETBIOS-compatible networks. The product was tested on both 3Com's Ethernet and IBM's Token-Ring LAN systems. The network operating system was Novell in both cases, and the Novell NETBIOS emulator was resident for each LAN system test.

NETMAN uses about 250KB, according to the documentation supplied by the manufacturer. Brightwork Software suggests that any PC running a help desk have at least 512KB of RAM.

The program's performance is not what one might expect on a high-speed LAN such as Ethernet or Token Ring. When a remote PC (or AT) is monitored, the screen refresh is noticeably slower than normal. The delay is as if the machine were running on a fast serial connection (such as 9,600 or 19,200 bps), instead of LAN packet speed. The refresh comes in spurts, rather than a smooth flow.

Brightwork could improve NETmanager's database option by including a provision for the program to analyze the user's equipment and perform some of the administrator's burdensome data-entry work. Although this process could not detect the kind of modem or printer on a remote PC, it could very well detect system memory, type of drives, and other PC features.

Another improvement is suggested: when one selects a user to monitor, it would be helpful to see a list of the users on the LAN who have the NRLISTEN program loaded—and which listening options are selected.

A 10-user version of NETmanager sells for $1,195. A full-site, one-building license sells for $1,495; this price includes local bridging. Both NETMAN and NRLISTEN programs will run on an IBM-compatible computer with either color or monochrome screens.

As LANs become larger, network administrators most likely will face a heavy amount of running around to troubleshoot faults and answer users' questions. NETmanager—despite its drawbacks—accomplishes this purpose well, saving LAN administrators the cost of a new pair of sneakers.

—CHARLES ROSE

TECH NOTEBOOK

A forum for sharing solutions to technical problems.

1 BASIC SYNTAX

2 DRIVE QUIZ

The first item in our Notebook is from Robert Stearns, an EDP Project Analyst at the Advanced Computational Methods Center at the University of Georgia in Athens. It is a reminder that porting programs from one compiler to another involves much more than just syntactical compatibility of the source language.

Darius Thabit, an electrical engineer and freelance software developer from Cambridge, Massachusetts, sends an interesting puzzle to test your knowledge of DOS trivia. In addition, he addresses the problem of determining from a program which disk drive identifiers are valid under DOS. His intriguing method is complemented by some of my comments about solving this problem on a network.

1 BASIC SEMANTIC DIFFERENCES

When programmers compare several compilers and interpreters for the same language, most often they consider only the syntactical compatibility of the source code: does each of the processors accept the same source program? But even more important is the semantic compatibility: given that the same program compiles and runs, does it produce the same results from each compiler or interpreter? The following program illustrates a semantic difference between the IBM BASICA interpreter and two popular BASIC compilers, Turbo BASIC by Borland and QuickBASIC by Microsoft.

```
10 A% = 1550
20 B% = 500
30 X! = A% * B%
40 PRINT X!
50 Y% = A% * B%
60 PRINT Y%
```

This program's syntax is equally acceptable to the BASICA interpreter and both compilers, but the results (as shown in table 1) are quite different. The differences arise from the different ways in which the problem of integer overflow is handled in lines 30 and 50. The BASICA interpreter notices that in line 30, the result is assigned to a floating-point variable, so the interpreter performs the multiplication in real mode to prevent overflow. The result displayed for X! is correct. In line 40, regardless of how the calculation is performed, there is no way to stuff the answer into the integer variable Y%, so the overflow error occurs.

The Turbo BASIC and QuickBASIC compilers both blindly perform the multiplication in integer mode, without regard for the disposition of the answer. As a result, both multiplications cause overflow errors.

Turbo BASIC adds one other serious consideration. By default, that compiler turns off overflow checking. This generates faster code, but can lead to unnoticed errors when the overflowing results are accepted without notification. The error is easily noticeable here but might not be in other situations, in which the erroneous result might be closer in sign and magnitude to the correct one, or not displayed immediately but used in further calculations.

BASICA and QuickBASIC do not allow overflow errors to be ignored. Despite this, for most programs QuickBASIC produces faster code than does Turbo BASIC. For a comparison of Turbo BASIC and QuickBASIC 3.0, see "BASIC Face-off," by Justin Crom (September 1987, p. 136); a review of QuickBASIC 4.0 is in preparation.

The moral of this tale is that in porting a program from one compiler to another, just as in the initial development, a clean compile does not necessarily mean a correct program.

TABLE 1: *Results from Three BASICs*

	IBM BASICA	BORLAND TURBO BASIC		MICROSOFT QUICKBASIC
Version	3.3	1.0	1.0	3.0 and 4.0
Overflow check	On[a]	Off[b]	On	On[a]
Result: X!	775000	−11432	Overflow	Overflow
Y%	Overflow	−11432	Overflow	Overflow

[a] *Cannot be turned off.* [b] *Default condition.*

The differences arise from the way in which each compiler reacts to integer overflow. BASICA is the most flexible, modifying the mode of computation to match the data. Turbo BASIC's default condition is to ignore overflow errors.

2 VALIDATING DRIVE LETTERS

This item begins with a quiz. The following is the entire source for a program that, in a scant 4 bytes, provides a useful function. It could be the shortest useful program there is:

```
MOV AH,4CH
INT 21H
```

What does it do? We will return to this later, after introducing the next topic.

The problem addressed here is the determination of whether a given drive letter (or number) refers to a valid disk drive under DOS. In DOS 2.x, that information could be obtained from interrupt 21H, function EH (select disk). Besides making a specified device the default drive, the function

also returned the total number of drives attached to the system. For DOS 2.x, all valid drives were numbered consecutively; therefore, a drive number was valid if it did not exceed the number returned by this function.

Things changed with DOS 3.0. Since that version, function EH returns either the actual number of installed drives or the value corresponding to the drive letter in the LASTDRIVE statement in CONFIG.SYS, whichever is greater. LASTDRIVE specifies the last letter that *could* be made valid, without regard for how many block devices are actually installed. Furthermore, the letters need not be assigned consecutively. For example, if function EH returns 6, that does not mean that drive letters C: through F: are valid; any or all could be uninstalled.

The reason for divorcing the LASTDRIVE statement from the number of actual installed devices is twofold. First, the SUBST command can activate new drive letters as aliases for subdirectories on existing devices. Second, a network can add block devices. In both of these cases, the new drive letters do not have to be consecutive; unused drive letters may be interspersed among the valid ones.

So the problem is, given an arbitrary drive letter, determine if it is a valid device. DOS contains no function to determine this directly. The closest is function 44H (IOCTL), subfunction 8 (removable media check). For a given drive number, it returns one of three results: removable, fixed, or invalid. There are, however, two problems. The first, less significant of the two, is that IOCTL subfunction 8 is not available in DOS 2.x. Although a concern for compatibility with that older version is becoming less and less important, DOS 2.1 is still extant and some applications may need to run with it.

The second problem is more serious: IOCTL subfunction 8 is not valid for network devices, and returns an "invalid function" error. One could take the occurrence of this error as a positive indication that the drive in question is a network device and therefore valid, but such design is not the hallmark of a robust application.

The most obvious solution is to perform some harmless function on the drive question, for instance, "get allocation table information" (function 1CH) or "get current directory" (function 47H). The disadvantage of these is that they entail physical I/O overhead; for removable-media drives that is too time-consuming and can result in "drive not ready" errors.

One drive operation that does not initiate physical disk activity is the select disk function, EH. It does not return any error codes to indicate an attempt to select an invalid drive; in that case, it just leaves the current drive unchanged. A simple algorithm for validating drive x is then as follows:

- Get the current default drive with function 19H; save this value.
- Select x as the default drive with function EH.
- Get the new default drive with function 19H. If it is x, then x is a valid drive.
- Restore the default drive to the one obtained in step 1.

A program illustrating this algorithm is given in listings 1 (DRVALID.ASM) and 2 (DRVALID1.ASM). Listing 1 is an assembly language mainline program that calls a procedure to do the validation. The procedure as written can be called from C and most other high-level languages; as noted in the comments, you need to activate the proper return instruction and may need to modify segment and entry-point names to conform to your compiler.

The value returned in AX (for most compilers, that is the value returned by the function) is 1 if the drive is valid, 0 otherwise. This convention allows the function to be used in highly readable constructs such as **if (drvalid(** . . . and **if (!drvalid(** . . . .

This algorithm, unfortunately, is not foolproof. A problem crops up, again, with those pesky networks: function EH appears to select some invalid drive numbers successfully. For example, if drives A through D are local devices, and H through M are network ones, a program can select drive E, F, or G with function EH. However, DOS knows the truth; attempting to change to an invalid drive from the keyboard results in "invalid drive" messages.

In a networked environment (where validating drives is especially important), the most reliable method is provided by IOCTL subfunction 9, "determine if drive local or remote." Given a drive number in BL, the function indicates its location by the value returned in DX. The value has bit 12 set if the device is a network device, and reset if it is local. The other bits in DX are reserved; they are not significant in current versions of DOS. For invalid drives, the function returns with the carry flag set; and it shows an error code of FH in AX.

This method of validation is shown by DRVALID2.ASM, the procedure in listing 3. It can be used with the same mainline driver; simply remove the semicolon from the appropriate **include** statement in listing 1. This procedure provides more information than does listing 2. The returned value not only indicates the validity of the drive but also shows its location: 0 if invalid, 1 if local, and −1 if remote. However, the demonstration mainline of listing 1 differentiates only between zero and nonzero returned values.

This second procedure is limited to DOS 3.1 and later versions. It appears that there is no reliable, version-independent method of validation. For applications that need compatibility with both DOS 2.x and networks, the best approach might be to incorporate both of the methods presented here and to choose between them on the basis of a DOS version test.

Now to reconsider the quiz at the beginning of this item. The program executes an immediate return to DOS—therefore it seems to do absolutely nothing. But it does do something—it returns the contents of the AL register as a completion code that can be tested by a parent process. Batch files can test return codes with the **if errorlevel** statement. So what is in AL when this program terminates?

As a vestige of its CP/M origins, when DOS loads a program, it attempts to parse the first two command-line parameters into file names each consisting of a drive letter, root name, and extension. Unfortunately, the loader does not parse path names, making this feature less than useful in an environment of tree-structured directories. But for bare unqualified file names, DOS splits out the three components and inserts them into file-control blocks (another obsolete legacy of CP/M) in the Program Segment Prefix. It also does one more thing, and that is the key to the mystery program—it validates the drive letters found in these file names and loads the results (0 if valid, FFH if not) into AL for the first parameter and AH for the second.

This 4-byte program (let's call it ISVALID.COM) then provides a quick-and-dirty method of validating drives from the keyboard or a batch file. If it is invoked with a parameter beginning with a drive letter, it will return an error level of 0 if the drive exists and

255 otherwise. The following batch-file fragment illustrates the usage:

isvalid c:
if errorlevel 255 goto no_C_drive

The colon (:) is essential; without it, the parameter is interpreted as a file on the default drive, and the resulting error level is zero. If the drive to be validated is itself a parameter of the batch file, the usage could be

isvalid %1:

When the colon is hard-coded, the program works whether or not the user types in a colon; an extra colon does not affect the outcome. While providing some measure of safety, this approach is far from foolproof. For example, a parameter longer than one letter cannot be fixed by a trailing colon nor otherwise trapped in a batch file. And on a networked system, this program has the same problem as the procedure of listing 2: it incorrectly validates nonexistent drive letters interspersed among valid ones.

LISTING 1: DRVALID.ASM

```
; DRVALID - Demo mainline driver to demonstrate DRVALID procedure
;   Needs conversion with EXE2BIN after linking

CODE      SEGMENT
          ASSUME  CS:CODE, DS:CODE

          ORG     80H
PARMLEN   DB      ?               ; length of command line
          DB      ?               ; blank
DRLETTER  DB      ?               ; drive letter parameter

          ORG     100H            ; start of code
MAIN      PROC
          JMP     PASTDATA

ERRMSG    DB      'No drive letter specified'
          DB      0DH, 0AH, '$'
OKMSG     DB      'Drive is valid', 0DH, 0AH, '$'
NOTVALID  DB      'Drive is NOT valid', 0DH, 0AH, '$'

PASTDATA: LEA     DX,ERRMSG       ; prepare for no-arg error
          CMP     PARMLEN,0       ; command line parms?
          JE      MAINX           ; no: exit w/error message

          MOV     AL,DRLETTER     ; get drive letter
          AND     AX,NOT 20H      ; convert to upper case
          SUB     AL,40H          ; convert to number (A = 1)
          PUSH    AX              ; pass as arg to procedure
          CALL    DRVALID
          LEA     DX,OKMSG        ; assume it's OK
          OR      AX,AX           ; test return value
          JNZ     MAINX           ; OK if non-zero
          LEA     DX,NOTVALID     ; else show other message
MAINX:    MOV     AH,9
          INT     21H
          MOV     AX,4C00H        ; DOS exit
          INT     21H
MAIN      ENDP

;         include DRVALID1.ASM    ; activate one or the other
          include DRVALID2.ASM

CODE      ENDS
          END     MAIN
```

LISTING 2: DRVALID1.ASM

```
;*****************************************************************
;
; DRVALID Procedure
;         For non-network applications, DOS 2.0 & above
;
;   Written by Darius Thabit
;
; C language calling sequence:
;   valid = drvalid(drnum)
;   int drnum: drive number to be validated, A = 1
;   int valid: return value; if non-zero, drnum is a valid drive.
;
;*****************************************************************

DRVALID   PROC
X         EQU     4               ; arg offset on stack,
                                  ; use 6 for far call
          PUSH    BP              ; standard procedure entry
          MOV     BP,SP
                                  ; push other regs as needed,
                                  ; depending on your compiler
          DEC     [BP+X]          ; convert to zero-origin numbering
          MOV     AH,19h          ; get original default drive #
          INT     21h
          MOV     BL,AL           ; save it in BL
          MOV     DX,[BP+X]       ; get drive # to be validated
          MOV     AH,0Eh          ; make it the new default drive
          INT     21h
          MOV     AH,19h          ; get the new default drive #
          INT     21h
          MOV     CL,AL           ; save it in CL
          MOV     DL,BL           ; restore original default # to DL
          MOV     AH,0Eh          ; make it the default again
          INT     21h
          MOV     AX,1            ; insert "drive valid" return code
          XOR     CH,CH           ; convert new drive # to word
          CMP     CX,[BP+X]       ; did new drive become default?
          JE      EXIT            ; yes: exit w/1 in AX
          DEC     AX              ; no:  exit w/0 in AX

EXIT:                             ; pop other regs as needed (not AX)
          POP     BP              ; standard procedure exit
;         RET                     ; use for C only
          RET     2               ; use for all other languages
DRVALID   ENDP
```

LISTING 3: DRVALID2.ASM

```
;*****************************************************************
;
; DRVALID Procedure
;         For network applications, DOS 3.1 & above
;
;   Written by Ted Mirecki
;
; C language calling sequence:
;   valid = drvalid(drnum)
;   int drnum: drive number to be validated, A = 1
;   int valid: return value; if non-zero, drnum is a valid drive.
;
;*****************************************************************

DRVALID   PROC
X         EQU     4               ; set to 6 of far call

          PUSH    BP              ; standard procedure entry
          MOV     BP,SP
                                  ; push other regs as needed,
                                  ; depending on your compiler
          MOV     BX,[BP+X]       ; load test drive # in BX
          MOV     AX,4409H        ; IOCTL for drive location
          INT     21h
          MOV     AX,0            ; code for invalid drive
          JC      EXIT            ; test for error from DOS call

          MOV     AX,1            ; code for local drive
          TEST    DX,1000H        ; test local/remote bit
          JZ      EXIT
          MOV     AX,-1           ; code for remote device

EXIT:                             ; pop other regs as needed (not AX)
          POP     BP              ; standard procedure exit
;         RET                     ; use for C only
          RET     2               ; use for all other languages
DRVALID   ENDP
```

Open Protocol Technology

The Better Bridge Between Computer Systems

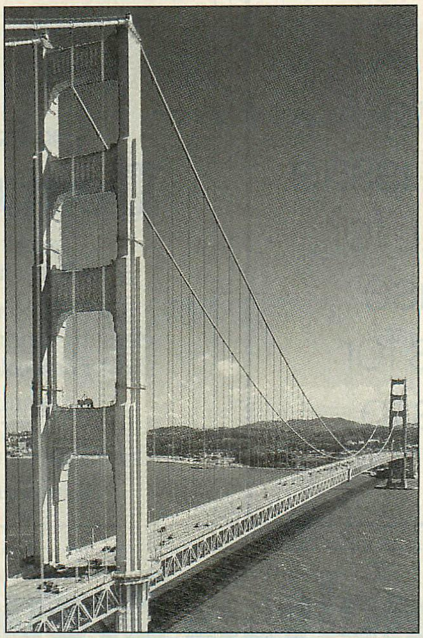
A bridge is a device for carrying things over a river. So is a ferry. But when you're driving across a river there is a great difference between taking a bridge and taking the ferry. When you drive across by bridge, you just continue doing what you were doing—the rules of the road don't change. When you cross by ferry the rules change—you park until the ride ends.

A bridge, in the world of NetWare,® connects across the great gulf between two computer networks. Like a river bridge, a NetWare bridge is an ideal way to travel. It connects two networks without changing the rules of the road—an application program working with a bridge, for instance, doesn't need to know which network the data is coming from.

When files travel across a NetWare bridge, the ground rules remain the same regardless of which physical network the files come from. This convenient lack of change is called "transparency" or "seamlessness"—the user or application "looks" across the bridge and sees no difference in the rules for dealing with files.

With NetWare, as many as fifteen bridges can be looked across transparently. In practice, this means that NetWare-based LANs offer great flexibility in building multiple LAN environments. A company's departmental LAN environments can grow independently without sacrificing expense or performance when the time comes to join them together.

For instance, a company could start with a department LAN consisting of Ethernet® hardware in the office. Shortly thereafter, the production people could decide a Token-Ring LAN suits their needs, and install one on the factory floor. When the time comes to link them together, it would merely be a matter of adding an adapter board, stringing some cable, and quickly reconfiguring NetWare to activate the bridging function.



"The concept of the transparent bridge is the heart of Novell's Open Protocol Technology."

Once the bridge is forged, users on both sides continue to use the same utilities they've always used to control access to their files, and to files and file servers on the far side of the bridge. The bridge is transparent.

This means that the ultimate LAN configuration in a building, company, department, work group, or any other organization can be a complex interweaving of many LANs, which are physically different but uniform in their software and their response to user commands.

Extending the Bridge Concept

The concept of the transparent bridge goes beyond just connecting LANs to LANs. It is the heart of Novell's Open Protocol Technology (OPT). The goal of OPT is to have other computer systems connect to a LAN and remain just as transparent to applications and users as NetWare bridge connections are now.

Novell is in the bridge-building business. It is our intent to connect wider and wider circles of networks. Novell's purpose for OPT is to ease the journey for application programs and end users by allowing the rules of the computer road to remain the same; regardless of where users travel through the world of networks.

Call 1-800-LANKIND if you would like to receive a copy of Novell's full Universal NetWare Architecture report.

For more information, call from your modem 1-800-444-4472 (8 bit, no parity, 1 stop bit) and enter the access code NVLROPT3.

NOVELL.

OUTFITTING THE END USER

Collegial Computing

P.C. Coffee

Rather than making PCs "less personal," networks and other connectivity options can do much to enhance work relationships.

Lately, PC pundits have taken to protesting the increasing emphasis on computer connectivity. "We're taking the *personal* out of personal computing," they fulminate. "Don't give ground back to Big Brother!"

This aversion to connection often seems to stem from a gut-level suspicion that the wire in the wall is a threat to free will. It is like the reaction of one of my students when I discussed Trojan Horse programs and the counterinsurgent programs that detect them: "But once the Trojan is in the machine," the student asked, "what's to stop it from doing what it likes?"

The notion that programs are just dumb data until you tell the machine to run them was difficult for the student to grasp. Similarly, I wonder if some users suspect that cabling their computer will transform the machine into a drooling, mindless terminal.

This confusion is unfortunate, because the resulting perspective—an emphasis on computing as a personal activity, rather than a collegial process—is much like the philosophy that has brought other technologies, like transportation, to a state that pleases no one. One has only to look at Los Angeles to see the situation that can result when the convenience and autonomy of stand-alone devices—in L.A.'s case, automobiles—are tenaciously retained even though the result is to strain the rest of the system.

It is hard to stand firm against the belief that the easiest tasks are also the most useful. Upgrading CPUs is certainly easier than connecting them. Today, however, the drive to put ever more powerful nodes on individual desks—without paying comparable attention to their connection—is at least as inappropriate as equipping the company motor pool with Formula 1 racing cars. In either case, not only are you buying more power than the typical user can effectively exploit, but you are embedding it in a context (whether local streets or keyboard interfaces) that seriously limits its value, even in the hands of an expert.

This is not just a theoretical perspective; I say it from the painful position of one whose new UNIX workstation is connected, at present, only to the AC power line. It makes a dandy text editor and C/UNIX training environment—LISP runs well, too—but it is not picking up much of the workload yet because the keyboard is the only way to talk to it.

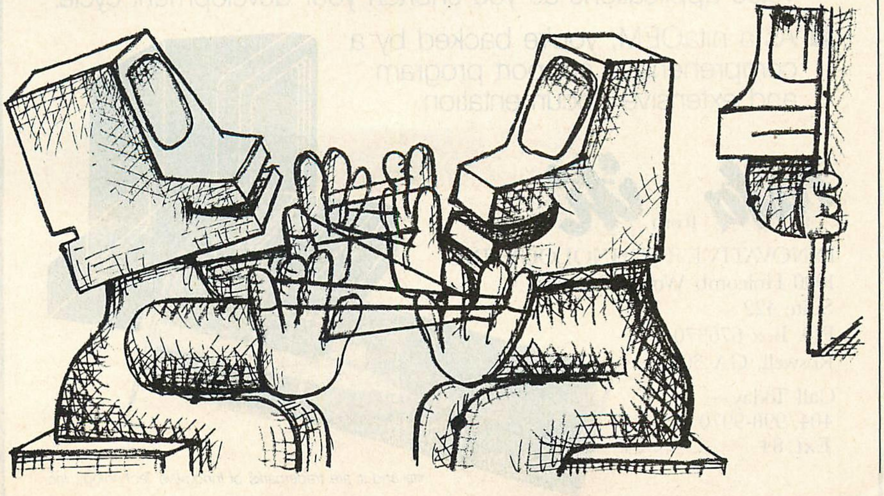
We will hook it into our Ethernet in another week or two, whereupon it should be a *very* popular place to work. Right now, however, in its considerable spare time, it serves as an object lesson in the importance of balancing the ability to pump bits around inside the machine with the ability to pump them back and forth with the rest of the world.

By contrast, I recently prepared a lengthy report using a Macintosh (mainly because my references were already abstracted in a *Guide* hypertext file). When the report (my chapter of a much larger effort) was ready, I asked the project coordinator how I should deliver it. "It's going to the Wang," he said. "How about a 5.25-inch disk with ASCII text, carriage returns at paragraph ends only?"

Describing the conversion almost takes longer than performing it: make a few global replacements to convert special characters to standard ASCII, send the file up to the mini, then bring it down to a co-worker's PC via modem. The whole process was really no more trouble than walking down the hall to the copying machine.

Sure, I could have used off-the-shelf hardware (such as Daynafile from Dayna Communications) to perform such media conversions without intermachine connectivity. The point, however, is that *with* a high level of connectivity I can use existing facilities *without* making each machine in the office a universal device.

In a highly connected computer environment, the entire suite of machines—as well as the code and data each computer contains—becomes a group resource to be shared in the same way that co-workers share their knowledge and experience. People become less territorial about their personal machines, because the benefits of mix-and-match computing so greatly outweigh the occasional inconvenience.



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THE CART BEFORE THE HORSE

Thinking about connectivity—and about other contacts between computer and outside world—can change your concept of system performance. To return to my transportation analogy, think of the isolated workstation and our various PCs as motor vehicles. The workstation is a turbine-powered 24-passenger van, sitting in a locked garage with the motor idling at 6,500 rpm. You can sit in it and play the stereo, but it won't go anywhere. The smaller machines are a fleet of golf carts busily hauling the mail and towing us out of tight places. Which class of machine is better earning its keep?

Such situations arise with computers more often than cars for two reasons. The first is that the waste is much less conspicuous. A computer that is throwing a MIP or three at the task of "wait for next key" is not nearly as noisy as an idling Ferrari.

The second reason is a matter of time: it takes a while for a company to identify the levels of difficulty that correspond to various levels of system capability. In the absence of well-written guidelines—based on parameters such as the size of the typical document, spreadsheet, database, or development effort that the machine will support—the user community inevitably turns to power users for help.

For the best reasons in the world, power users tend to over-recommend. Paste this message on your bathroom mirror, where you can study it every morning: "Plenty of users out there can still do everything they need with an 8088- or 8086-based machine, let alone an AT compatible with 640KB; you are not insulting their jobs or abilities by telling them so." You can buy many more of the cheaper platforms, or you can be even more sensible and spend the difference on good backup devices and a decent printer that can feed both plain paper and letterhead.

Let me suggest an exercise. The next time you are asked to help a user configure a system within a budget, select the system unit last. Find out which applications will be used and get an idea of the volume of data that has to be kept on line. That will dictate the size of the hard disk and determine the display and output-device requirements (printer, plotter, etc.). *Then* look at what you can afford for a CPU.

In effect, figure out how big a cart you need to move the required load—then find out if you can afford enough horses to pull it. Why not buy the horses first? Carts (disks, displays, etc.) are not getting cheaper nearly as quickly as the horses (processors and memory), so if you buy an upgradable machine, dropping in an accelerator board next year won't cost much more than buying the big box in one piece today. By deferring the processor upgrade, you can start to build the application tools and produce the quality of output that you want your customer to associate with your organization.

Scrimping on peripherals to buy the sexy CPU just produces shallow, amateurish-looking results more quickly. Instead, put the same money into big, fast, hard disks, a good tape backup unit, and a printer that does not misfeed every time a truck goes by outside. The problems that can cost you hours of time will disappear at the expense of waiting a few more seconds for a global replace. And while you're at it, budget for connectivity.

WE HAD OUR REASONS

In defense of all of us, we have good reasons for having come so far along the path of powerful nodes with grossly inadequate connectivity. The first is a matter of momentum: we have continued to improve certain aspects of performance long after they have ceased to be the principal problem.

Early PC software made the user painfully aware of the byte-wide bottlenecks between processor and memory or between keyboard and screen. Tasks that we were used to doing as fast as our eyes and brains could handle—like thumbing through a document—were annoyingly slow on an 8088.

This was especially a problem for unfamiliar users trying to grapple with inconsistent interfaces. Having finally learned that they had to press the Enter key to make the machine recognize a command, they were horribly confused when they ran into an application (such as VolksWriter or Lotus 1-2-3) that used single-key commands and required no Enter stroke. They would press the command key listed in the menu; when nothing seemed to happen, they would say "Oh, right" and dutifully hit the Enter key. The program would wind up executing the Enter stroke—usually a secondary-menu default—after it finally got around to doing what the user had intended in the first place.

This behavior would often snowball until the user was several (unintentional) commands ahead of the pro-

gram. The time required for the machine to respond to each command was so long, and the indication that it was doing anything at all was so subtle, that the user became hopelessly confused. You would almost have to sit on the user's hands and say, "Wait. Don't do anything. Watch the screen. Look at the LEDs on the disk drives. Tell me *when it seems* to have settled down."

Eliminating these long response times, and improving other conspicuous aspects of performance such as scrolling speed, has spawned untold megabytes of dirty code. Part of the blame must go to the grossly inadequate I/O services provided by DOS—higher performance in clean I/O will be one of the most significant advantages of OS/2. But this still does not completely explain how we got to where we are today.

The second reason that we have emphasized stand-alone performance rather than connectivity is a natural consequence of the first. Once we were used to the responsiveness of dirty code, especially with memory-mapped rather than serial-interface displays, anything that dragged us back down to the speed of external interfaces seemed painfully slow. File transfers or other communications seemed a ridiculous waste of a machine that we knew could perform other tasks—stand-alone tasks—substantially faster.

A reasonable solution would have been to take full advantage of the capacity of 80286- and 80386-based machines for sprightly response in heavily interactive applications, while putting their (mostly) unused power during keystroke wait loops to work for background communications. Unfortunately, our third and final good reason was that doing our connectivity tasks in the background (where their leisurely pace was not so annoying) was much too uncomfortable and risky under real-mode DOS, where—to put it bluntly—many programs crash.

Indeed, under real-mode DOS, this is an essential truth that ranks right up there with "light is fast" and "space is big." Having more than one program running at once, in an architecture where runaway code can stomp on anything in its way, greatly multiplies the chance of sudden death—like a cat losing all nine lives at once. Some systems, Quarterdeck's DESQview for one, provide a virtual boot that gets you out of a process without rebooting the whole machine; the terminate option under Microsoft Windows/386 is analogous. Neither traps all cases, however, as many of us have found.

The interrupt-driven nature of communications in particular, coupled with the risk of losing those interrupts in first-generation "edge-triggered" architectures, made communications one of the most dangerous background tasks. Thus, acceptable performance for interactive applications made external connectivity both unattractively slow and operationally risky. Tapping the raw single-tasking power of new processors had more market appeal.

THE BEST EXCUSE IS GONE

Added to these technology and human-factors problems has been an important management problem. An organization can buy computers one or two at a time or, more important, adjust the number to be bought in response to budget slack or tension; until recently, however, the infrastructure of connectivity has been a "big chunk" purchase of equipment.

The outlook for connection becomes less forbidding with recent options such as Ethernet when run over inexpensive twisted-pair conductors (unused telephone wires rather than bulky coaxial cable). Another alternative, the Integrated Services Digital Network (ISDN), would give each user a $2B + D$ connection to the network: two B channels with a capacity of 64 kilobits per second (Kbps), used for digitized voice or other data, plus a 16-Kbps D channel used for signaling.

Though hypothetically most useful as the architecture of future public systems, the basic ideas of ISDN are appearing today, on a smaller scale. As Joan Trude of Booz, Allen and Hamilton suggested (*ISDN Report*, December 15, 1986), "Large users—unwilling to wait for public ISDN—[will] implement selected pieces of ISDN functionality through enhanced private networks," possibly skimming off the most profitable sector of the market and making public ISDN economically impractical.

The key point here is that the best excuse for not doing something about connectivity—the high up-front cost of getting a "data drop" to every desk—is rapidly disappearing.

THE POINT OF THE PYRAMID

The prospect of dramatic reductions in the cost of connectivity can help answer those who dispute the value of desktop multitasking—whether achieved through OS/2, UNIX/XENIX, or DESQview/Windows-class technol-

ogy. The multitasking skeptics point out, with some justification, that we sound like ancient Egyptian architects. "You are arguing over the shape of the point of the pyramid," they protest, "when most of the workers don't even realize that they are not just building a wall." That wall perceived by the typical user is the single application—word processor, spreadsheet, database—that most users perceive as what their PC is meant to do. Relatively few users are working at a level where they can even see—let alone use—several sides of the pyramid at once.

But this is a straw-man argument against multitasking, because it assumes that the capacity for multiple tasks will be used to perform the same tasks that PCs do today—just simultaneously, or at least in rapid alternation, rather than in individual sessions. For most users, who need little more than the capability of current terminate-and-stay-resident (TSR) utilities, this is indeed a capability of questionable value.

Look, however, at all the functions that your machine should be doing for you that it does not do today. For example, it is a criminal waste of people's time to be playing telephone tag trying to schedule meetings: their calendars should be available (at least at the level of "this time is still free") to be interrogated by calendar programs on the machines of their co-workers.

Today's PC-based time managers merely ensure that those who use them are unable to schedule a follow-up session until they get back to their individual offices. This is a problem with the *incomplete* use of such systems rather than their use *per se*; the solution would be to have a terminal in the meeting room that can access the same calendar information.

Universal connectivity within an organization could make an enormous difference in the ease of getting jobs done. Today, however, we have to allow for the fact that any given desktop may not have any kind of terminal on it; in practical terms, this means that systems must still be designed for paper technology.

For example, doesn't it strike you as peculiar that laser printers are used merely to emulate the production of the same old multiple-copy forms that business has used ever since the invention of carbon paper? If you were to follow the path of each copy and ask the recipients what information on their respective copies they will actually use, you might find that each is really only interested in a few fields of the record, in the database sense, that the complete form represents.

Indeed, some may be interested only in summary statistics, such as the total expended by a department during a period versus the corresponding budget. They have *to compile these* summaries themselves, and they probably save the paper copies as backup. Our current systems transport physical copies of *all* the details of our operations to *all* prospective users, instead of giving each the scope and level of information that is actually useful.

Wouldn't it be great if instead of multicopy forms, you could just fill out (on your screen, of course) the equivalent of one master form, then tell an expediter program to take care of it? Necessary portions of the content would be sent to the appropriate nodes of the network. Approvals that did not depend on one another could actually take place in parallel, while reviews that needed to be sequential would be automatically managed by the program. Instead of having to chase down the actual piece of paper to find out who needed to be prompted to get it moving, you would receive net mail from the expediter as each milestone was reached; alternatively, you could ask at any time for a log of all transactions affecting the document. Signature approval, using any of several systems, would probably be tighter than it is today. People would be able to sign their names from any terminal, even when out of town.

The potential applications of reliable background tasking in well-connected environments are truly vast.

MAKING IT HAPPEN

Before any organization can feel it is on the way to this kind of future, it must make some fundamental decisions. The first is to consider connectivity (even if it is just a modem and an extra telephone line) to be as basic in configuring a system as buying a keyboard and a display. The second decision is to enable everyone in the organization to find out what information each is tracking, and in what form.

Now we get into the fantasyland that computer types conjure up with the magic word *architecture*. This is an often-abused term, but when applied as a serious set of goals it can have a wonderful clarifying effect. Meeting these goals is politically difficult, but can be made easier with some ideas I will present next month.

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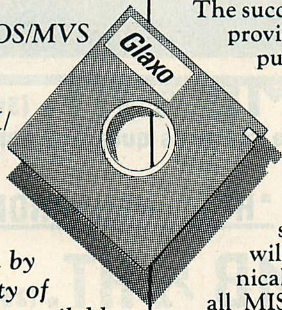

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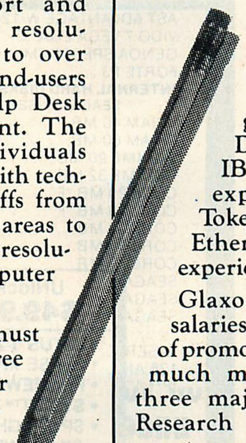

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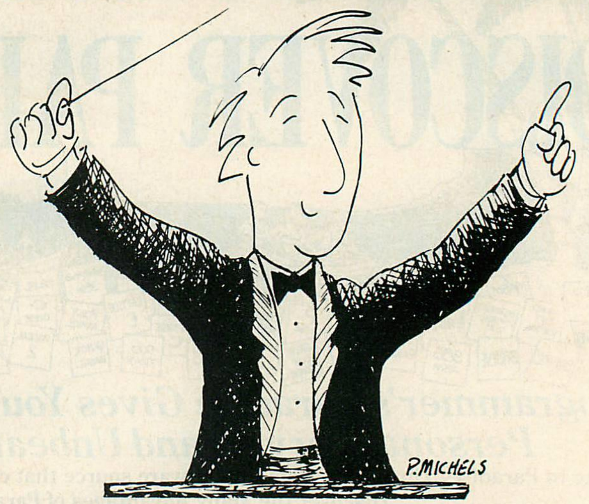

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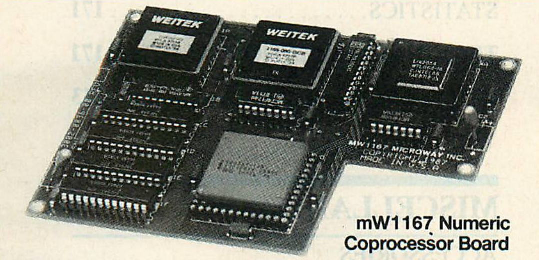

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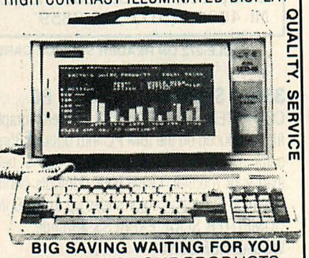

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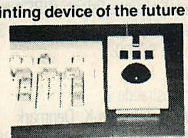

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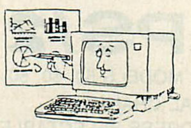

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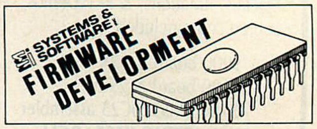

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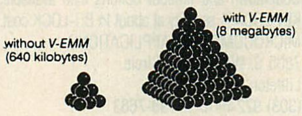

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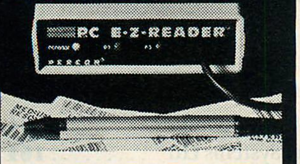

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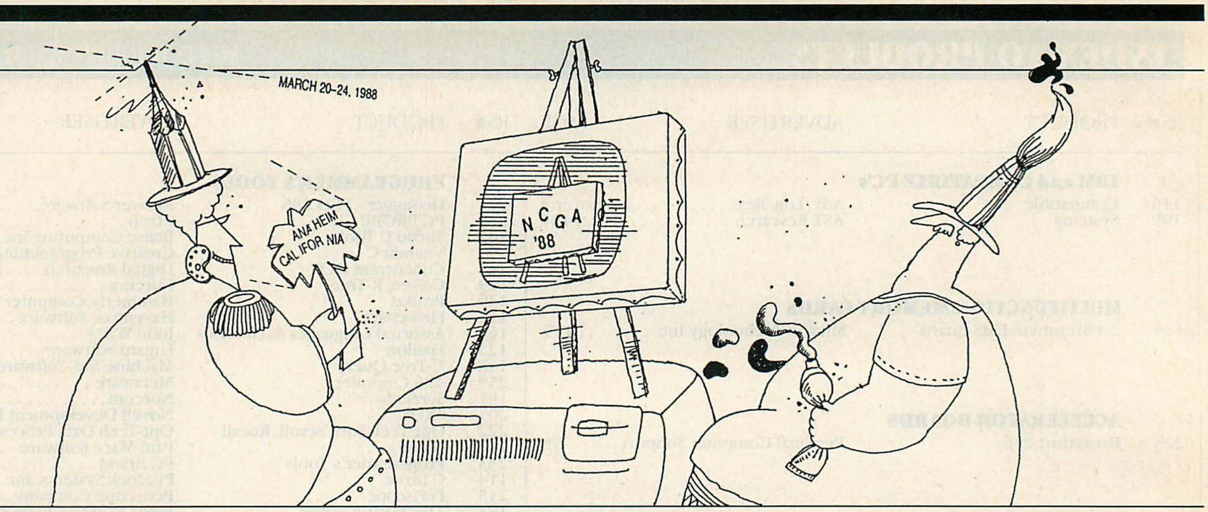

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MARCH

March 3–4
LISP: Expert Systems Builder's Tools
Atlanta, GA (Georgia Institute of Technology) *Contact:* Deidre Mercer, Education Extension Services, Georgia Institute of Technology, Atlanta, GA; 404/894-2547

March 7–10
Computer Workstations
Santa Clara, CA (IEEE-CS) *Contact:* Patrick Mantey, 335A Applied Science Bldg., Department of Computer Engineering, University of California at Santa Cruz, Santa Cruz, CA 95060; 408/429-2158

March 8–10
Technical Conference for MIS/DP Professionals
New York, NY (Cahners Exposition Group) *Contact:* Cahners Exposition Group, 999 Summer Street, Stamford, CT 06905; 203/964-0000

March 8–11
International Symposium on Digital Communications
Zurich, Switzerland (IEEE-CS) *Contact:* Secretariat 1ZS 88, c/o P. Gunzburger, Hasler AG, TDS, Belpstrasse 23, CH-3000, Bern 14, Switzerland; 41-31-632808

March 10–11
APPC Communication
San Francisco, CA (Systems Technology Forum) *Contact:* Sherry Armstrong, Seminar Coordinator, Systems Technology Forum, 10201 Lee Highway, Suite 150, Fairfax, VA 22030; 800/336-7409; 703/591-3666

March 14–17
National Conference on Ada Technology
Washington, DC (U.S. Department of Defense) *Contact:* Al Rodriguez, U.S. Army Communications-Electronics Command, Fort Monmouth, NJ 07703; 201/532-4725

March 20–24
NCGA Annual Conference
Anaheim, CA (National Computer Graphics Association) *Contact:* NCGA, 2722 Merrilee Drive, Suite 200, Fairfax, VA 22031; 703/698-9600

March 21–23
Computer Standards Evolution: Impact and Imperatives
Arlington, VA (IEEE-CS) *Contact:* Computer Standards Conference, IEEE, 1730 Massachusetts Avenue, NW, Washington, DC 20036-1903; 202/371-0101

March 21–25
World Users Conference
Los Angeles, CA (MacNeal-Schwendler Corporation) *Contact:* MacNeal-Schwendler Corporation, 815 Colorado Blvd., Los Angeles, CA 90041; 213/258-9111

March 28–31
World Congress on Computing
Chicago, IL (Interface Group) *Contact:* The Interface Group Inc., 300 First Avenue, Needham, MA 02194; 617/449-6600

March 29–31
Conference on Optical Storage of Documents and Images
Washington, DC (Rothchild Consultants) *Contact:* Rothchild Consultants, 256 Laguna Honda Blvd., San Francisco, CA 94116-1496; 415/681-3700

APRIL

April 11–13
Computer Networking Symposium
Arlington, VA (IEEE-CS) *Contact:* George K. Chang, 6 Corporation Place, Piscataway, NJ 08854; 201/699-3879

April 11–15
International Conference on Software Engineering
Raffles City, Singapore (IEEE-CS, NCB, and ACM) *Contact:* Tan Chin Nam, 71 Science Park, Singapore 0511; 65/772-0200

April 11–15
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Brussels, Belgium (IEEE-CS) *Contact:* Jacques Tiberghien, VRIJE Universiteit Brussels, Pleinlaan 2, 1050 Brussels, Belgium; 32-2-641-29-05

April 25–27
Computer-aided Software Engineering Symposium
Boston, MA (Digital Consulting) *Contact:* Carole Germain, Digital Consulting Inc., 6 Windsor Street, Andover, MA 01810; 617/470-3870

April 25–28
Expert Database Systems
Tysons Corner, VA (George Mason University) *Contact:* Edgar H. Sibley, GMU, ICSE Department, 4400 University Drive, Fairfax, VA 22030; 703/323-2779

MAY

May 5–6
Modeling and Simulation
Pittsburgh, PA (U. of Pittsburgh) *Contact:* William G. Vogt, 348 Benedum Engineering Hall, U. of Pittsburgh, Pittsburgh, PA 15261; 412/624-9686

May 9–12
COMDEX/Spring '88
Atlanta, GA (The Interface Group) *Contact:* The Interface Group Inc., 300 First Avenue, Needham, MA 02194; 617/449-6600

May 15–19
Human Factors in Computing Systems
Washington, DC (ACM SIGCHI) *Contact:* Gail Chmura, 5214 Monroe Drive, Springfield, VA 22151; 703/750-9401

May 24–27
Measurement and Modeling of Computer Systems
Santa Fe, NM (ACM SIGMETRICS) *Contact:* Connie Smith, Performance Engineering Services, 1114 Buckman Road, Santa Fe, NM 87501; 505/988-3811

May 30–June 2
Computer Architecture
Honolulu, HI (IEEE-CS, ACM, and SIGARCH) *Contact:* H. J. Siegel, Supercomputing Research Center, 4380 Forbes Blvd., Lanham, MD 20706; 301/731-3700

May 31–June 3
National Computer Conference
Los Angeles, CA (American Federation of Information Processing Societies) *Contact:* AFIPS, Preston White Drive, Reston, VA 22091; 703/620-8900

JUNE

June 5–9
Enterprise Networking Event
Baltimore, MD (The U.S. MAP/TOP User's Group and the Corporation for Open Systems) *Contact:* Carol Hamel, The Society of Manufacturing Engineers, One SME Drive, P.O. Box 930, Dearborn, MI 48121; 313/271-1500

June 5–9
Computer Vision and Pattern Recognition
Ann Arbor, MI (IEEE) *Contact:* CVPR 88, The Computer Society, 1730 Massachusetts Avenue, N.W., Washington, DC 20036-1903; 202/371-0101

June 6–9
Decision Support Systems
Boston, MA (The Institute of Management Sciences) *Contact:* TIMS, 290 Westminster Street, Providence, RI 02903; 401/274-2525

June 12–15
Design Automation Conference
Anaheim, CA (SIGDA and IEEE) *Contact:* Pat Pistilli, M.P. Associates, 7366 Old Mill Trail, Boulder, CO 80301; 301/530-4333

June 21–24
USENIX Summer Conference
San Francisco, CA (USENIX Association) *Contact:* Judith DesHarnais, USENIX Conference Office, P.O. Box 385, Sunset Beach, CA 90742; 213/592-3243

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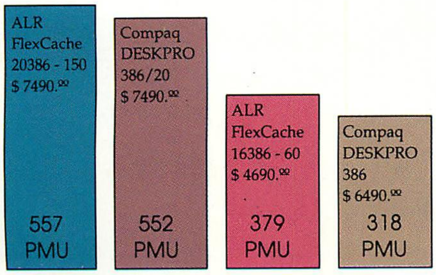

Power Meter Performance Index

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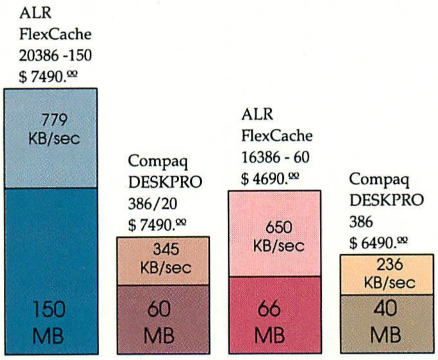

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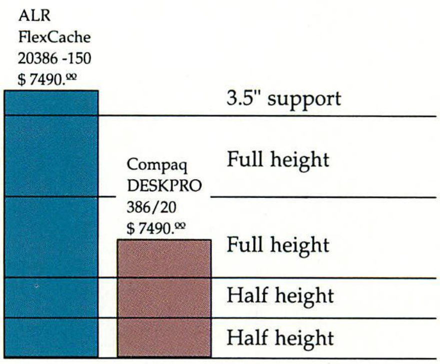

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